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Conceptions of Excellence in Primary Mathematics Teaching

Submitted to the Open University for a Doctorate in Education

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Abstract

This research had two drivers: the persistent demand by policy makers for educators to achieve 'excellence' in teaching without defining what is meant nor agreeing how to achieve it; the paradoxes encountered by teachers across education who create their identity through a need to reconcile their personality, life stories, professionalism and the political agenda. The research question was 'How is excellence in primary mathematics teaching perceived by primary teachers and mathematics teacher educators in England?' and analysis drew upon literature about education, mathematics education and the theoretical perspectives of social constructivism and socioculturalism. An interpretative approach was adopted to explore understandings and beliefs about what comprises excellence in mathematics teaching. Data were gained from four groups – student, non-specialist and mathematics specialist teachers, and university mathematics education lecturers – through interviews which produced both narrative and mind-maps. These were analysed thematically.

The analysis revealed and illuminated surprising and interesting new perspectives. The main outcomes were: three interwoven and interdependent themes (confidence, knowledge and supererogation) which contribute together to create excellent teaching in primary mathematics; two dichotomies exemplifying the complexities of teaching; and the unexpected emergence of 'good enough' being sufficient to meet targets. The three key themes will resonate with the teaching profession, providing an aid to articulating their embedded, implicit guild knowledge. The dichotomies and the notion of 'good enough' highlight the professional conundrums that teachers encounter. They have to reconcile their professional identity and beliefs with the exigencies of belonging to communities of practice as well as outside expectation and requirements. The research showed that excellence is an aspirational ideal, embodied in the child who is the product of excellent teaching. This research contributes to an understanding of factors impinging upon the development of excellent teaching (in mathematics education and beyond), thereby offering ways forward to educators and policy makers.

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Glossary of abbreviations

ACME	Advisory Committee on Mathematics Education
ATM	Association of Teachers of Mathematics
AfL	Assessment for Learning
AoL	Assessment of Learning
BEd	Bachelor of Education
BERA	British Educational Research Association
BSRLM	British Society for Research into Learning Mathematics
CAQDAS	Computer-Assisted Qualitative Data Analysis Software
CMM	Constant Comparative Method
CPD	Continuing Professional Development
DESA	Department of Economic and Social Affairs (United Nations)
DfE	Department for Education
DfEE	Department for Education and Employment
ECOSOC	Economic and Social Council
FHEQ	Further and Higher Education Qualifications
GCSE	General Certificate of Secondary Education
HEI	Higher Education Institute
ICT	Information and Communication Technology
IMF	International Monetary Fund
ITT	Initial Teacher Training
KPMG	Merger of Peat Marwick International and Klynveld Main Goerdeler
LA	Local Authority
MaST	Mathematics Specialist Teacher
NCETM	National Centre for Excellence in the Teaching of Mathematics
NNS	National Numeracy Strategy
OECD	Organisation for Economic Co-operation and Development

Ofsted	Office for Standards in Education
PGCE	Postgraduate Certificate in Education
PGCert	Postgraduate Certificate
PISA	Programme for International Student Assessment
QAA	Quality Assurance Agency (for higher education)
QTS	Qualified Teacher Status
SATs	Statutory Assessment Tests or Standard Attainment Tests
SEN	Special Educational Needs
TDA	Training and Development Agency
UCET	University Council for Education of Teachers
UoW	University of Winchester

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Chapter 1 – Introduction

This chapter introduces the research which was to ascertain conceptions of excellence in primary mathematics teaching. It opens with the background context that informed the rationale for undertaking the research followed by the research question, the research approach and finally the structure of the thesis.

1.1 Rationale and background

In my professional role I have worked at all levels of the university as lecturer, programme leader, head of department and chair of the university quality committee. I have been struck and then increasingly irritated by the persistent rhetoric and demand by policy makers for educators to achieve 'excellence' in teaching whilst not defining what is meant or agreeing on the means by which to achieve it. In this context the position, political and professional, was ripe for investigation. 'Excellence' is a quality attracting adjectives such as 'outstanding', 'extremely', 'exceptional' (Cambridge Dictionaries, 2013; Oxford Dictionaries, 2013; Webster Dictionary, 2013) and therefore is about being better than good; it is approaching perfection. It is an emotive term and is subject to being defined by external criteria and social change; for example a teacher deemed excellent in 1965 may not be assessed as excellent in 2014 and vice versa.

One definition and means to achieve excellence in teaching came to the fore in 2007 when the Secretary of State for Education, Balls (DCSF, 2007) decided teaching was to become a Master's profession. This intent was endorsed by Gove (DfE, 2010). Balls judged that the knowledge, skills and understanding needed to be an excellent teacher equated to postgraduate expectations (defined by the QAA) and that it was possible that these aims could be met through a combination of academic and work settings.

However, I was aware at my higher education institute (HEI) of the tensions between academic and practitioner requirements experienced by teachers undertaking continuing professional development (CPD). We were already providing the many and varied courses required by schools and these had a very good take-up rate and attendance. However, once the teachers completed a course, predominantly the schools only wanted them to feed back in order to initiate action for school improvement. In contrast, to be able to award a postgraduate qualification, we required an academically sound submission, adhering to QAA requirements.

Some teachers were sufficiently self-motivated to complete the award but I knew that they had more than one draw on their time and energy as teachers and as postgraduate students: to themselves as individuals, as teachers and, by projection, to their pupils. They were juggling possibly conflicting factors such as personality, life stories and professionalism that teachers undergo to construct their identity. As a consequence of the above factors, the completion rate was very low. I was interested to see if the added expectation of the political agenda to complete a Master's degree would improve teaching or become an additional burden that detracted from developing excellence.

Thereby resides my motivation and rationale for undertaking this project. However, it soon became evident that the field of excellence was an extensive, potentially vast area to research. It was necessary to impose some boundaries for the purpose of this study and to achieve depth rather than breadth, I required a focused approach. As a consequence, I decided that my research area would relate directly to my professional lecturer role, that of primary mathematics education; I would concentrate on perceptions and beliefs of excellence in primary mathematics teaching in England. The study endeavours to determine - from the perspective of the particular groups of people who form the participants - what is meant by excellence in primary mathematics teaching and does not attempt to determine how to achieve it. Through this research, I sought to gather evidence, determine patterns, identify realities and place these in the context of the drivers that inform practice. My intention was to

add to the body of knowledge about excellence in teaching through consideration of practitioner, management and policy makers' views. In conclusion I have drawn implications and recommendations for the practices of members of these three groups.

The preliminary study and reading undertaken for my research allowed a wide-ranging exploration of issues associated with education and teaching. This initial examination of extensive views and perspectives provided broad, rather than narrow, insights into knowledge and understanding of the field (see Scheurich, 1997). The literature examined at this stage considered several interrelated areas: the purpose of education in general and mathematics in particular including historic contributions to change and educational ideologies; the nature of teaching, goals and how impact is measured; and the nature of mathematics and knowledge.

Each commentator on historic and current views of a teacher had a stance influenced by his or her particularly combinations of knowledge, understanding and experience. Each policy maker's view of primary mathematics teaching creates politically motivated changes. One such was a key recommendation of Williams (2008:1) for "the presence of a Mathematics Specialist in every primary school, who will champion this challenging subject and act as the nucleus for achieving best pedagogical practice". The government at the time took up this proposal. The following government supported the initiative, recognising its value although it changed, and then withdrew, the funding for the programme (DfE, 2011). The qualification for these Mathematics Specialist Teachers (MaSTs) of a postgraduate certificate (PGCert) was awarded by universities. There were three key aims that informed the programme: to develop the mathematics subject knowledge of the specialist; to develop a fit-for-purpose pedagogy; to develop the expertise needed to work with colleagues in schools (UoW, 2009). As an additional step to improvement, Truss (DfE, 2014:1) declared that teachers from China were to be brought in for their "can-do attitude" to show English teachers how to have high expectations and to support the struggling children. This resolution may have indicated a belief that the MaST initiative had not been successful although insufficient time had passed

for impact to be determined. An alternative possibility, as MaST was put in place by the previous government, was that Truss's move was politically motivated.

1.2 Research question

This research had a single question: 'How is excellence in primary mathematics teaching perceived by primary teachers and mathematics teacher educators in England?' During the process of reviewing the literature and analysing the findings, other subsidiary questions arose, concerned with: the role of the child; the impact of respondent biographies; the importance of subject knowledge; the necessity for excellent teaching. However, as these questions arose within the process of conducting the research rather than being originally conceived to support the initial question, they are not addressed discretely but are embedded within the discovery of answers to the single original question.

1.3 Research approach

The focus of this enquiry was to determine understandings and beliefs through a variety of sources including empirical data drawn from four groups of respondents with different experiences and expertise in primary mathematics. The research adopted an interpretative paradigm drawing on situated cognition using a sociocultural viewing lens, paying attention to the relationship between concepts such as 'self' and 'identity' and the role of the context in professional identity formation. Thus it was possible to examine the context and the individual that contributes to the teacher's professional identity as well as the nature of knowledge about excellent teaching: who creates it, how it is created and how this is known (Fenstermacher, 1994; Beijard *et al*, 2004).

Accordingly the ontology of the enquiry adopted a nondualist stance in which "person and social world are internally related to one another, mutually constituting" (Packer & Goicoechea, 2000:234) and "the known and the knower are interdependent" (Maykut & Morehouse, 1992:12). The epistemology was the study of the way meaning was constructed

or acquired for or knowledge about those things, that is, through the interpretative paradigm. This was based on basic assumptions about the nature of the phenomena being studied, the nature of the research process and the kind of knowledge to which it can lead. Indicative words such as beliefs, aims and means may perhaps be correlated with ontology, epistemology and methodology. With ontology acting as a motive force, these form a dynamism through which beliefs, aims and means are not discrete and not inert.

This was achieved through using an interpretative approach (Maykut & Morehouse, 1992). To answer the research questions open, unstructured interviews were chosen as a single method for collecting empirical data. The outcomes of these interviews were twofold; interview transcripts and mind-maps. The latter were undertaken at the end of each interview to provide the respondent with the opportunity to consolidate what they had discussed through highlighting key issues that arose and to make connections between them. Consequently I had a way into the respondent's professional, social and cultural world, creating access to the knowledge, skills, cognition and emotions that contributed to their identity (Atkinson, 2005; Yin, 2009). The interviews with the mind-maps enabled the respondents and me to work together to gain in-depth understanding of their conceptions of excellence in teaching; and to explore how these conceptions were manifested in each respondent's particular situations (Newby, 2010).

1.4 Thesis structure

This introduction has given the rationale for the study and the reasons why I considered it was a topic worthy of study. The second chapter reviews the literature with consideration of general aspects of the factors that contribute to excellence in education, literature relevant and specific to excellent teaching in mathematics, predominantly in the primary age range and relevant theoretical perspectives. Chapter three addresses the methodology employed, and includes the research aim, research question, the nature of educational enquiry, the approach adopted, sampling, data collection and analysis methods for the preliminary and main studies,

the role of the researcher, ethics and rigour. Chapter four presents the findings from the respondents and is arranged in three main themes, each with several sub-sections. Chapter five is a discussion of these findings, presented in three parts. The first part presents a metaphor and contextualises the themes presented in the findings. Part Two examines the two dichotomies: the intrinsic motivation of the child as a learner and the extrinsic incentive using the child as the measure of success; the teacher determining outcomes or if required outcomes determine teaching. Also explored are the means to becoming excellent and the difference between good and excellent with consideration of 'good enough'. Part Three examines how the research outcomes might be attributed to the stances held by the respondents. The final chapter draws together the study by highlighting key findings, considering how the study contributes to the body of knowledge. It continues with a critique of the methodology and methods used, and concludes with reflections on the study and implications for further research. The outcomes will contribute to knowledge in the field of teacher education through illuminating the many contributing issues and by determining the views of those responsible for creating excellent teaching, thereby offering ways forward to educators and policy makers.

1.5 Conclusion

This research is aimed at different audiences. First it is for primary teachers to provide conviction to their endeavours to be excellent teachers or resolve to those for whom this seems neither possible nor desirable. It is also for managers who need to know why they should motivate and develop teachers who are reluctant, under-confident or even recalcitrant. It is for those who support the managers in their determinations. It is for policy makers to provide evidence to show that long term and short term targets are may be different but are not irreconcilable; that longitudinal research should be established to ascertain what is achieved. Encompassing these, it is to hearten those who believe that the child who is the product can be both the purpose for excellent mathematics teaching and the tool by which

successful education is measured. Finally, it is for the children who not only succeed in meeting the targets set but who also profit by deriving joy and confidence with flexible and creative expertise, allowing them to revel in the beauty, culture and subjective realism of mathematics.

Chapter 2 - Review of the literature

As noted in the introductory chapter, the focus of this research was primary mathematics teaching and this literature review will examine how excellence in primary mathematics education is perceived. To introduce this, the review will consider some overarching factors influencing decisions made about education within which primary mathematics education is situated. The review will then reflect upon *why* mathematics is part of the primary curriculum, both functional and aesthetic before moving on to include *how* the teacher might achieve excellence with consideration of theories, beliefs and values of relevant educationists and research as well as the individual perspectives and identities of teachers. Also evaluated are other factors that contribute to learning such as motivation and inequities in practice. Peripherally, *what* is to be taught is taken into account. Next follows a consideration of educational ideologies pertinent to mathematics teaching and the literature review finishes with an exploration of the theoretical standpoints of seven theorists. The rationale for considering the key theorists was primarily to contribute to the later discussion of the findings of the study, rather than inform the research question or methodology of the study.

2.1 Literature search strategy

The literature search was wide-ranging, drawing on relevant historic and contemporary texts, papers from research and academic debate as well as policy documents and political pronouncements. The research considered primary mathematics education in England so most of the literature was drawn from English sources. These resided predominantly in university libraries and were sourced through the search terms that form the sections of the review. Greater insights were established through follow-up searches using social science databases (EBSCOhost, Zetoc) and publishers' databases. The search for the overview of education was not date limited as the intention was to scope the extent and nature of existing perspectives of education.

The literature review was predominantly to establish the contemporary knowledge base specific to mathematics education in England and so empirical research studies were the main focus, although philosophical, theoretical work was included where relevant. The search started with both recent mathematics education specific texts, written for use by teachers and trainees, (for example Hopkins *et al*, (1999), Hughes *et al* (2000), Anghileri, (2001), Barmby *et al*, (2009), Brown, (2010), Cotton, (2013), Haylock & Manning, (2014)) and the journals of professional mathematics education bodies (The Advisory Committee on *Mathematics* Education (ACME), Association of Teachers of Mathematics (ATM), British Society for Research into Learning Mathematics (BSRLM), National Centre for Excellence in the Teaching of Mathematics (NCETM)). These indicated additional search terms and references leading to searches for citations arising from these papers. The location focus of this research meant that studies conducted in the UK, particularly England, were the prime sources examined. However, research conducted in other countries was included where particularly relevant.

2.2 Introduction

A starting point for examining primary mathematics teaching is to consider the purpose of education. Over time, many educational theorists have expressed their views, summed up by Ernest (1991), who stated that education exists for a reason; it is organised and undertaken intentionally. The aims of education are derived from these intentions and are therefore determined politically, resulting in any esoteric and academic aims, Ernest (1991) and Halsey *et al* (1997) note, in subservient roles against the requirements of the marketplace. The relationship between society and culture has been raised repeatedly by commentators such as Jacks (1931) and Zielger and Peak (1971) who observed a disconnection between what education should do and what it does. Aldrich (2005) and Wilkinson (2007) accommodated this, stating that education, and by association educators, should hold to two professional tenets: the development of children to meet their civic responsibilities for the betterment of

the lives of the people in their community and to create citizens who will contribute to democracy.

Additionally, the literature concurs that education ought to have the interlinked purposes of being relevant to society and the economy and also to the individual's quality of life. It might be considered that individuals have an entitlement to be educated and that society, through its government, has a duty to ensure this occurs (Ernest, 1991). If education creates good, contented, productive citizens, these will be more use to society. Hence the consensus is that education should not be a passive process; it should engage people actively so they have the power to question and innovate, rather than echo. Those who have responsibility for the economic welfare of a society also have control over the education systems and, consequently, how decisions about education are made "reflects both the distribution of power and the principles of social control" (Bernstein, 1971:135).

Ronnstrom (2012) and Roth (2012:259) identified the view that an education for a global future, rather than focus on competitive, economically driven outcomes, should create autonomous cosmopolitan citizens by "pursuing the highest good [...] in the world together". Teachers are required to educate the now recognised diversity of learners, to meet these needs of an increasing varied and rapidly changing society within a bureaucratic structure that inhibits responsiveness (Jarvis *et al*, 2003). For a product that is of value to society, education, and hence each teacher, needs to prepare the child for whatever life will ask of it, being capable of independence and self-reliance (Pittenger & Gooding, 1971). Alexander (2007) conjectured on issues such as the values that education should embrace, how the best learning was to be achieved and how quality should be assured. However, as Alexander (*ibid*) observed, the means by which teachers are to achieve progress for primary education and the purposes it would need to serve in the twenty first century is unclear.

2.3 Character and nature of mathematics

One of the difficulties presented to those who determine the character and nature of education is the requirement to meet the needs of a diverse population who will in turn meet the needs of society (Brown, 2010). In extension, society has multiple and diverse contributions to make to economic stability and growth, direct and indirect (British Academy, 2012). The societal view was also pursued by the Advisor Committee on Mathematics Education (ACME) (2008) who noted that the high proportion of time devoted to mathematics in the curriculum is a recognition of the need to serve society and to prepare individuals to flourish in that society. This should mean that there is time for teachers and pupils to explore the subject despite the need to meet their professional commitment to a broad and balanced curriculum. An additional consideration was raised by Wiliam and Thoresen (2009) in justifying their stance for the centrality of mathematics; in their report to the Scottish government they stated that not only do mathematics have increasingly embedded relevance to both the world of work but also to people's personal lives. As Hopkins *et al* (1999) noted, there is little use in being able to complete pages of sums but not know how to start on unfamiliar, everyday problems, and to enjoy drawing on the relevant mathematics through logical reasoning. Hughes *et al* (2000) also considered the purpose of being numerate, suggesting that it is not to do school mathematics but to be able to use that mathematics whenever it is needed. They note that it is common for people not to be able to transfer mathematics learned for one purpose to another purpose or context. Hence, teachers need to be aware that this is an additional requirement towards ensuring excellent learning in mathematics.

This concurs with Suggate *et al* (1998) who added that mathematics requires understanding if it is to be of use and it is not of use or understood if it cannot be applied appropriately.

National Numeracy (2012) noted that from individual to global level, poor numeracy has both direct and indirect impact. They cite KPMG figures that suggest the cost to the economy of failing to address the issue of poor numeracy would be twenty seven times that of the cost of

remediation. The report further claimed that the world of work the children presently at school will encounter will require increasing mathematical adeptness. Teachers are challenged to determine how and what to teach their pupils to meet a need not yet defined but the consequences of failing to meet this demand will result in unemployment, reduced productivity, increase in crime and social, emotional and behavioural difficulties (National Numeracy, 2012).

In England, mathematics is seen as a subject with solutions that are either right or wrong (Barmby *et al*, 2009). However, the postmodern view of mathematics is that it is fallible, in direct contrast to an absolutist view (Ernest, 2008; Izmirli, 2011) and therefore teaching should draw in the “natural curiosity of the child” (Llewellyn, 2012:385). One advantage of taking the fallibilist view is that this reinforces the view that mathematics are socially constructed as well as designed to serve the needs and values of society. The absolutist view separates school mathematics from its potential application in other spheres, and is counter to the social world from which it arises (Ernest, 2008; Brown, 2010). Understanding in mathematics involves broad experiences so that the understanding of a concept is tied in with the context within which it is learned. Learning is therefore achieved through children building up connections to which mathematical reasoning contributes (Barmby *et al*, 2009). Within this, misconceptions are inevitable and predictable but productive, adhering to the social constructivist philosophy of mathematics education. This uses fallibilist beliefs to enable pupils to thrive within mathematics, rather than being outside whilst mathematics teaching is ‘done to them’ (Ernest, 1991, 1998; Mason & Johnston-Wilder, 2004).

One dominant and agreed school of thought, echoing the definitive work by Krutetskii (1976), holds that not everyone will be able to achieve the same understanding of mathematics (Betts & McNaughton, 2004) although the expectation of mastery proposed by NCETM (2014) may present a different view. In another change in perception, in proposing their features of mastery, NCETM (2014) considered that all but a few children will work at the same pace on

the same tasks, raising questions about appropriate provision for the lowest and higher attainers. With the mastery approach, there is no need for strategies to close the gap as there will be no gap to close with any differentiation being achieved through intervention approaches. This is possibly counter to knowledge that learners all have different starting points and many influencing and contributory factors (Turner, 2013). Orton, (1992:4) reflected that “individual differences are very significant in many spheres of human activity” so perhaps it is reasonable that this is also true for mathematics. From these contrasting views of children’s learning, the problem for the teacher is to determine whether they deliver the curriculum directly related to age or to development.

Betts and McNaughton (2004) acknowledged there are degrees of access to and use of mathematics from the basic functional to those who “find mathematics to be beautiful and of value in a cultural and historical context by doing and understanding mathematics” (p62). They extended this to promote the need for mathematics to be valued for its aesthetic nature which in turn will provide capacity to consider not only what is of value but who decides. Mooney *et al* (2014:2) commented on both society’s need for “functional numeracy” and “the awe and wonder of mathematics, the creativity and elegance” and Krutetskii (1976) noted the joy of pupils arriving at an elegant solution. More prosaically, Suggate *et al* (1998:1) remarked that mathematics “offers its own intrinsic satisfactions” as well as its more practical, everyday life purpose. They continued, remarking that mathematics “enables us to communicate thinking and reasoning; [it] embodies a precise language”. This was supported by ACME (2008) who asserted that the aim of learning mathematics must be greater than achieving certain levels at certain times. They (and Krutetskii, 1976) were clear that mathematics has value and purpose for its own sake as well as for its applications to professions and jobs. Boaler (2014) supported the concerns of Askew (2012), like McNamara and Barwell (2004) and D’Ambrosio (2010) that what is taught in schools has very little connection to what would be of value in

either of the two contexts of individual and societal need. What is taught in school has much to do with meeting the political agenda.

2.4 Mathematics in education

The views of current teachers about how to teach mathematics will have developed from and upon the historic perspectives before, during and after their own schooling, initial teacher training and continuing professional development. Haylock and Manning (2014) listed their view of the aims of teaching primary mathematics (utilitarian, application, thinking skills, aesthetics, epistemology) which resonate down the years and Brown (2010) explored this by drawing on the analogies of 'pendulum', 'swings' and 'roundabout' to examine the nature of mathematics education since the 1850s. Even then, it was thought that number sense was as important as mechanical arithmetic but the ways in which this has been managed has varied. For example, in the first national curriculum (NC) (1862), recognising that children progress at different rates and, acknowledging a seven year range of attainment by the end of primary education), classes comprised mixed ages all working to one standard. On the other hand, the 1989 NC also acknowledged the different rates, highlighted in Plowden's (1967) and Cockcroft (1982) reports, but classes contained just one year span in age and children moved up to the next, regardless of progress.

Another variation of approaches to teaching mathematics identified by Brown (2010) was the nature of teaching strategies, arising from different beliefs about how children learn. Plowden (1967) and Cockcroft (1982) recommended that the best learning requires active response to experiences, experimentation and discussion. Thus children will become aware of relationships and develop mental structures and idiosyncratic mathematics. The result was many teachers used strategies to build understanding, avoiding drill and with a shift in attention from teacher to learner. This created a slower approach towards algorithms with less time to practice them when they were taught. The 1931 Hadow report wanted more than just arithmetic and the curriculum gradually became fuller and more diverse, with the Cockcroft report (1982)

endorsing a wider curriculum to contribute to improving attitudes thus providing the foundation for better understanding. However, alongside this and coinciding with the ending of the eleven plus examination, employers complained of a lack of numeracy in young employees (Brown, 2010). This culminated in the 1999 National Numeracy Strategy, even though the research base for its structure was limited and the term 'numeracy' indicated a curriculum that ignored non-numerical aspects of mathematics (Haylock & Manning, 2014). This term then disappeared from the 2013 NC (DFE, 2013a). Brown (2010) concluded that "maybe such swings are inevitable since standards will never be as high as we would wish and there will always be someone with a new vision ready to keep the roundabout turning" (p24). It falls to the teacher to interpret and manage the consequences of these changes whilst maintaining teaching that provides the best outcomes and opportunities for their pupils.

It may be that, rather than the mathematics itself, it is the perceptions and beliefs held *about* mathematics that create the dilemma for educators in mathematics. Culturally, it is acceptable to admit dislike for, anxiety about and incompetence in mathematics (Harris, 2012) with feelings of confusion and lack of confidence. Haylock & Manning (2014) identified guilt as prevalent amongst those adults who feel, by dint of their other successes, they ought to be confident; this includes primary teachers who have responsibility for the early stages of pupils' mathematics learning. Suggate *et al*, (1998:x) similarly commented that "mathematics has a troubled place in the emotions of many highly intelligent learners". They conjectured that one reason for this adult view of mathematics, regardless of success, was that perhaps they did not learn to struggle when they were learning, being subjected to mathematics which was made safe in order to pass the examinations. Mathematical engagement is as much influenced by attitude towards the subject as by understanding (Jackson, 2008). Haylock and Manning (2014) speculated about the connection between anxiety about mathematics and the tendency to present it as non-creative with success achieved through rote learning. After all, English as a subject, for example, is not viewed as just grammar and spelling but as a subject

that actively engages creatively with life (Turner, 2013). There is a particular kind of understanding held about the subject (Suggate *et al*, 1998) with three myths which pertain about mathematics: it is difficult, it is only for clever people and it is a male domain (Haylock & Manning, 2014). Primary teachers may well hold one or more of these beliefs and yet need to counter perpetuation in the pupils they teach.

Hence teachers need to acknowledge and address the nature of mathematics as well the mathematics for themselves and for the children they teach (Kelly, 2004). Not only does the current focus in mathematics arise from the contemporary social stance but also the image of mathematics presented and understood as envisaged by public and political perceptions (Ernest, 2008; Restivo & Collins, 2010). The nature of mathematics affects how it is learned and therefore should influence how it is taught. The way the mathematics curriculum is presented to pupils as a collection of disconnected parts, each taught discretely, does not reflect children's holistic view of the world (Hart & Allestaht-Snyder, 1996), a position highlighted in the Williams review (2008). Williams considered that mathematics is not a simple subject that can be easily separated into sections. This was previously espoused by Krutetskii (1976) who was clear that isolating mathematics would limit the potential to achieve optimum success. Targeting teaching on specific aspects of mathematics may bring improvements but Mason (2012:31) noted with concern that it is commonplace for the "successful completion of routine tasks [to be] taken as evidence that students know how to do something". Previously, Williams (2008) had warned that it is indeed possible to improve attainment this way but the offset was a reduction in engagement and enjoyment in mathematics.

Romero and Mari (2011:1) remarked that the point of mathematics education should be to ensure "comprehensive learning" and this supports the thoughts of Skemp (1976). He suggested that it is useful for mathematics educators to consider mathematics as what people understand rather than as content to be learned as knowledge and then functionally

performed. This view was shared by Williams (2012) who said that although pupils who learn knowledge through content can be successful in the short-term, this is generally not embedded and they do not possess the skills and cognition to apply what they have learned. However, this short-term retention arising from teaching mathematics as content does serve the purpose of meeting prescribed targets. Ernest (1998:221) argued that the mathematics taught in schools arises from an examination-driven curriculum and “is a set of artificially contrived symbolic practices, a significant part of the meaning of which is not already given but deferred until the future”. Boaler (2014:2) calls this policy “wrong-headed”, having little feeling of the role of “human creativity in sense making [which is an] often overlooked strategy” (Mason, 2012:31). This depersonalised view persists and indeed, it could be said that the mathematics in school “may not meet the needs and inclinations of any concrete person at any specific time” (Roth & Radford, 2011:152).

For many years there has been tension between procedural mathematics and conceptual, ‘number sense’ (Brown, 2010). She also commented that there has been a parallel tension between progressive and public education philosophies to support both the equal entitlements of pupils and to meet the skilled person requirements of the state. The pendulum has swung over time but Brown (*ibid*) notes that there is one constant, regardless of approaches to teaching – primary teachers tend to have poor number skills. It is interesting to note that, in a review of the literature on primary mathematics over the last 150 years, McIntosh (1981) found that there have always been concerns about teacher subject knowledge with no period better or worse.

To meet the perceived societal needs, children need life skills such as persistence, determination, flexibility and laterality. Boaler’s research showed that to gain these, they must learn how to “act with agency and responsibility” and be held “accountable for mathematical reasoning and sense making” (2012:59). Hence school mathematics has overt relevance and purpose as a “human endeavour” (Mason, 2012:37) beyond the classroom and

into the future, enhancing the teacher's role of "culture's custodian" (Brown, 2010:3).

However, Ofsted (2008, 2011, 2012) repeatedly noted that pupils had too few opportunities to use and apply mathematics, indicating limitations in the teaching they received. They found that the predominant approach focused on knowledge and performance skills with limited expectation of understanding. This was supported by Williams (2008), and later by Wiliam and Thoresen (2009), all recommending that schools paid more attention to embedding this cognitive aspect of mathematics. Although Williams (2012:9) asserted that "mathematics education is not an enigma" he did not pursue the implications this carried or identify any limitations or dilemmas for the teacher. He believed that we know how to teach primary mathematics well but the English approach is too timid; "we aren't teaching students to swim – we're teaching them to play in rock pools" (*ibid*:26). This was endorsed by Boaler (2014:1) stating that children "do not make conjectures, or learn creatively. Instead they sit watching teachers demonstrate standard methods, which they are forced to reproduce". One possible outcome of this is the view of the pupils that school mathematics is not interesting and has no purpose or use (D'Ambrosio, 2010), thus perpetuating the prevalent cultural view of mathematics.

Ernest (2011) and Boaler (2012), in pursuing the theme of mathematics being socially situated, suggested that pupils' learning of skills and knowledge was noticeably enhanced when teachers incorporated their knowledge of how their pupils engaged with mathematics – pedagogical subject knowledge. Teachers who deploy mathematics specific pedagogy provide opportunities for pupils to participate actively with the mathematics, which is the starting point for developing "adaptive expertise" in addition to "routine expertise" (Harano & Oura, 2003). This does not preclude the routines of learning through practice, even by rote, as this enhances the knowledge base. The important point is that the children are taught to use what is memorised to create a balance of conceptual knowledge and recall skills, thus contributing to confident and competent application in problem solving (Mason, 2012; Ofsted, 2012). In

this way, pupils' individual and personal achievements create the fundamentals on which "long-term, ongoing, individual patterns of attainment can be built" (Koshy & Murray, 2002). Familiarity with routines enhances success but is not best acquired "through mindless rehearsal of standard tasks" (Mason, 2012:30).

2.5 Teacher knowledge and approaches to teaching

Payne (cited in Aldrich, 2005) noted that knowledge of the subject, pedagogical subject knowledge and knowledge of the individual contribute to good teaching. These three elements underpin teacher education today but, as Shulman commented in 1989, until recently the determining factor for successful teaching was the possession of content knowledge, lacking distinction between knowledge of the subject and pedagogical subject knowledge. Shulman also provided three elements of excellent teaching but did not include the individual, instead, noting "subject knowledge", "pedagogical knowledge" and "pedagogical subject knowledge" (*ibid*:8). Cotton (2013) expanded these even further by considering mathematics' subject knowledge, mathematics' curriculum knowledge and pedagogical content knowledge.

To be able to teach well, teachers must not only be confident and competent in pedagogical subject knowledge but also have good knowledge of the subject so they understand the basic concepts and how they are interconnected (William & Thoresen, 2009). In 1994, Ofsted considered the role of the teacher in pupil attitude and achievement, noting that it was of concern that the teacher's poor knowledge of mathematics was a contributory factor in their pupil's low achievement. Arising from these concerns, interventions were put in place, through the National Numeracy Strategy (NNS) (DfEE, 1999) in particular, oriented around an assumption that primary teachers are not competent or confident in mathematics or mathematics teaching (Hardy, 2007). These teachers have been part of at least twelve years' mathematics education before their teacher training (for which they need to demonstrate basic subject knowledge of mathematics) so their subject knowledge should be secure.

However, the majority of primary trainee teachers are insecure with a negative image of mathematics, even though they have GCSE grade C or higher. They experience anxiety and fear, the weight of expectations, with worries about teaching and learning styles and language, inhibiting learning about pedagogy (Jackson, 2010; Haylock & Manning, 2014). Unfortunately, as Cotton (2013) noted, this is insufficient as good subject knowledge provides confidence to the teacher and in turn, will transmit that confidence to the pupils. Good subject knowledge also enables the teacher to make the informed choices about how they teach each particular mathematical concept (*ibid*).

However, as the research of Ball *et al* (2001) concluded, the minimum mathematics teachers should know was not necessarily effective when extrapolated into pedagogical subject knowledge. In particular the minimum does not develop the flexible approach needed to ask probing questions or interpret the often idiosyncratic routes developed by children who have the freedom from a solely procedural mathematics experience. Through their relationship with their pupils, teachers' own embedded beliefs and motivation will contribute to the way the pupils view mathematics (Mason & Johnston-Wilder, 2004). It is rare for teachers to see themselves as mathematicians (Turner, 2013) but Mason (2012:37) was clear that children's appreciation of mathematics is enhanced if teachers are "being mathematical *with* as well as *in front of* them". Pedagogically under-confident or under-competent teachers are reluctant to permit this freedom, reducing pupil engagement (Brown, 2010), and are unlikely to include aesthetic aspects to their teaching (Betts & McNaughton, 2004). The recommendations of ACME (2008) for a curriculum that allows teachers to make decision about teaching strategies to accommodate the needs of each individual assumed the capabilities of teachers to use this self-determination effectively. If this supposition is unfounded, as observed by Jones and Mason (2012), then teachers without confidence or conviction to promote or cope with the unexpected or unintended consequences will regress into safe, limited territory.

Llewellyn (2012:397) asserted that none of the “grand narratives” proposed for teaching mathematics will work alone and there is not one that is necessarily better or worse than another. To accommodate this conundrum of decision, each teacher should examine critically their personal views and representations, arising from the range of factors that have brought them to being a teacher, against the range of beliefs documented (Ernest, 2011, 2008; Askew *et al*, 1997). For example, there is agreement that a good teacher will anticipate errors and misconceptions, support learners coming to new concepts, generate probing questions, deal with unexpected questions and help pupils to make connections (Cotton, 2013). Additionally, one important factor is that whatever the teacher creates in their classroom is subjected to reflection. This will accommodate policy shifts such as from teaching procedures learned by rote to developing conceptual understanding and using pupils’ own thinking (Anghileri, 2001) and back again (DfE 2013a).

Another example is that of the use of text books, which have moved in and out of favour (Anghileri, 2001). Publishing companies move quickly to review existing schemes or create news ones each time a change is announced and it may be that they are not the problem but how they are used; they are a useful resource for teachers (*ibid*). Brown (2010) acknowledged that for all the swings most schools have continued with the basics (number work, tables, bonds), commenting that “the combined good sense and inertia of the teaching profession has substantially damped the pendulum swings [...] and no doubt will do so again” (p23). Orton (1992) concurred that through all the changes, it is the teachers who have the central role, not the curriculum, classroom or policies. The good teacher knows what contributes to effective, relevant learning in primary mathematics to ensure that it is the best possible environment in which the pupils can thrive (Orton, 1992; Grouws & Lembke, 1996; Bloomfield & Harries, 1999; Askew *et al*, 2010).

It is interesting that Askew *et al* (1997) chose the word ‘effective’ rather than ‘excellent’ in the title of their seminar work. Teachers who are effective at teaching adopt a range of

pedagogies that put the learner at the centre, combined with confident and flexible teaching (Williams, 2008; Wiliam & Thoresen, 2009; Askew, 2012). Murphy (2003:125) considered that there are two forms of pedagogical realism; “objective” in which the teaching will lead pupils to the one way and “subjective” in which the pathway to the solution may be variable and even idiosyncratic. Another position is to distinguish between learning a series of procedures and learning through building up conceptual understanding, creating the potential for strategic thinking. Skemp (1976:14) described “instrumental” and “relational” learning, and Askew (1997:3) “transmission” and “connectionist”, terms still in use. In conjunction with these ideas, following the Cockcroft (1982) report, there was an initial zealous response by mathematics educators which was to eschew all procedures, including rote learning, and only open questions were considered *de rigueur* with closed ones being bad form (Ofsted, 2011; Sangster, 2012). However, Askew *et al* (2010) were clear that these apparently polar opposites (and subject of continuing debate) may be successfully combined. This was confirmed by the extensive study of Nunes *et al* (2012) which concluded that while mathematical reasoning was a better indicator of future achievement than rote learning of arithmetic skills, arithmetic makes a “smaller, but nevertheless significant and independent contribution” (p152). Pupils need to establish an affiliation with mathematics otherwise “relational understanding will remain at arms-length, fragmentary and disconnected” (Mason, 2012:33). Star (2005) suggested that teaching to achieve relational understanding was an approach returning to mathematics education, with teachers using creative approaches combining a range of pedagogical practices. However, Star’s view was robustly contradicted by Boaler (2014).

A creative approach to teaching mathematics is powerful in developing a creative approach to mathematics itself and is particularly effective when pupils have the opportunity to self-determine the direction of their learning within the frame of teacher-planned intentions (Lev-Zamir & Leikin, 2011). This reduction in procedural learning will give relevance to the

mathematics, increasing the potential for transference to other aspects of mathematics and the wider curriculum so limiting the possibility of learning being only temporary with minimal internalisation (Kelly, 2004; McNamara & Barwell, 2004). Mason (2012:33/34) highlighted the “perennial question of whether it is better to teach procedures first and to expect conceptual understanding to grow, or to aim for conceptual understanding so as inform the use and carrying out of procedures”. He concluded that there is no right way; to persist in endeavouring to resolve the question “exaggerates and exacerbates rather than clarifies the problem”. This view was endorsed by NCETM (2014) who noted that one of the key features of mastery was that there should be no priority between technical proficiency and conceptual understanding.

Not only do creative approaches make learning more relevant and enjoyable for the pupil but it has been shown that they may develop understanding to a more advanced or deeper level than with less engaging approaches with the mathematics being taught through meaningless activity (Nooriafshar, 2004). This is particularly so when combined with teaching that recognises that individual needs may vary during the lesson as well as in longer time spans (Lev-Zamir & Leikin, 2011). Mason, (2012) proposed taking this further towards pupil generated learning using a problem solving approach through experiential learning which not only improves pupils’ mathematics skills but the independence gained contributes to enhanced confidence. When blended with the encouragement of intuition and idiosyncratic methods, experiential approaches will enhance understanding and flexibility, building on a post-modernist pedagogy (Izmirli, 2011) that creates children who do not just want to know “what to do next” but “how you know what to do next” (Mason, 2012:32). This play has the dual aims of developing understanding and promoting enjoyment, with the second achieved by using content as a vehicle rather than as the driver (Williams, 2012). This approach would avoid the detriment of reducing experiences into routine learning (Boaler, 2104). However, the NCETM (2104) features of mastery pedagogy require planning that contains small

sequenced steps, each mastered before the next is started, with the focus on curriculum content, which may not be compatible with experiential learning. Mason (2012:35) gave the example of “if you have to run down a printed list [of heuristics] to look for something helpful, you are unlikely to recognise something appropriate when you get it.” The teaching should therefore be delivered with a “pragmatic understanding of theory” (Yu, 2009), posing further challenge for the teacher to keep current with research as they progress through their career so they can rationalise not just what is taught and how this is done, but also why (Brown, 2010).

Askew *et al* (1997:19) noted that effective teachers not only use effective pedagogic strategies but also possess “well-developed personal philosophies [and] emphasise connections”. This enables them to deal with any inconsistencies they meet, for example teaching mental calculation strategies which then become procedures which children may use without understanding (Brown, 2010). Additionally, Williams (2008:61) stated that good teaching must be in conjunction with a “high-quality curriculum”. This will contain both overt and covert intentions as the curriculum is determined through legislation and is laden with the values, both implicitly and explicitly, of those who construct it. Furthermore the stages of planning for delivery and resultant learning, will have a range of implied or unintentional values of the school, teacher and pupil embedded (Ernest, 1991, 2008).

2.6 Targets, expectations and motivation

Targets can provide purpose and hence belief and motivation towards engagement in mathematics learning (Kloosterman, 1996) and the nature of those goals will require different forms of motivational strategies by the teacher (Hart & Alleksaht-Snider, 1996; Muthukrishna & Borkowski, 1996). These writers argued that a goal that is based on achievement through understanding will, with appropriate teaching, generate intrinsic motivation and therefore the outcomes are likely to reflect the pupil’s realistic capability, strengthen their motivation and deepen their engagement and interest. To achieve this, the teacher needs to set appropriate

goals (Kloosterman, 1996). The objectives set need to build on the expectations of high standards (NCETM, 2014) but they also need to be appropriate for the pupil. This is not necessarily easy to determine and as a result, what teachers plan and how they differentiate may not be appropriate. As Orton (1992:7) suggested, “in seeking the right middle road for all our pupils we often get it wrong for many”. As a result of teaching that is unsuitable or inappropriate, pupil anxiety increases, exacerbating the potential for demotivation.

After the revisions to the mathematics curriculum in the 1990s employers pressed for a revisiting of a utilitarian emphasis, which, combined with the introduction of standard attainment tests (SATs) lead to pressure to teach to the test (Brown, 2010). At the time, these did not have an expectation for standard algorithms but drew on the methods promoted through the NC and NNS although this was revisited over the next years, leading to their return in the 2013 NC (DfE, 2013a). One outcome was an increase in the use of ability setting to manage whole class teaching. An intention behind this was that the lowest achievers would benefit by being taught through a less creative, more didactic approach. They were taught to do mathematics so they would perform better, with the intention of shortening the tail of lower achievements. However, Brown (2010) noted that test results showed minimal improvement.

A goal based on performance, such as examinations, will engender a different set of affective responses and behaviour patterns and the teacher needs to understand and acknowledge these. If the purpose of meeting a goal in mathematics brings only extrinsic rewards, such as external regard, then this implies that success or otherwise is only of value because it pleases others. This appears to militate against the *Programme for International Student Assessment* (PISA) (OECD, 2012:18) findings which particularly noted, “Students whose parents have high expectations for them [...] tend to have more perseverance, greater intrinsic motivation to learn mathematics, and more confidence in their own ability to solve mathematics problems than students of similar socio-economic status and academic performance, but whose parents

hold less ambitious expectations for them.” However, it may be that parental regard brings intrinsic, as well as extrinsic rewards. Krutetskii (1976:16) and Payne *et al* (1999:38) noted in their research that when the prospect of an exam or test was removed, most of the students were greatly relieved. They admitted to negative feelings towards mathematics examinations ranging from “nervous” to “physically repulsed”.

Pupils who feel valued will make progress and their views of themselves as mathematicians will have a direct effect on their attainment (William & Thoresen, 2009; Askew *et al*, 2010). This is not a new view as Plato (427–347 BC) directed teachers: “do not train a child to learn by force or harshness: but direct them to it by what amuses their minds”. Motivation is a key player in pupils’ progress (Mason & Johnston-Wilder, 2004) and their desire to succeed, an effect that cannot be ignored (Orton, 1992) and a pedagogy that uses affective strategies, making the mathematics more appealing and exciting in addition to cognitive ones will draw in these pupils, enabling them to make progress (Pendlington, 2005). The images that the teacher projects about mathematics are a central contribution to the pupils’ beliefs and attitudes and it is these that determine engagement and hence motivation and progress (Ernest, 2008). Mathematics educators must enable pupils to develop “active mathematical identities that include self-belief as well as adaptive expertise” (Boaler, 2012:61). This requires the teacher himself to possess these characteristics.

However, recent developments have not always been successful in promoting pupil self-esteem. One of the principles promoted by the NNS (DfEE, 1999) was to place an emphasis on whole class active participation. This was underpinned by the tenet that by explaining their thinking, pupils would clarify their understanding. ACME’s research in 2008 noted a direct outcome of the NNS was a reduction or absence of self-esteem in those pupils who learned at a slower pace than their peers. This possibility had already been considered by Buxton (1981) and Muthukrishna and Borkowski (1996) who discussed risks in the overtness of answering questions in front of peers in a mathematics class. The outcome confirms to the pupils their

perceptions of their lack of ability and/or understanding and reinforcing failure. Therefore the motivation to participate in this way is reduced if the goals require them to risk humiliation. The consequences are reduction in confidence and the potential of reversal in attitudes towards mathematics (Orton, 1992). As Carr (1996:103) noted, “we know something about motivation, something about social influences, and something about cognitive and metacognitive development, but little about how these factors interact to bring about a given level of mathematical performance”.

2.7 Assessment

The evidence for the effectiveness of any adopted strategy is drawn from assessment and Askew (2012) considered the additional task of the teacher to prepare their pupils to pass tests. Previously he and his colleagues had concluded that high attainment in assessments does not necessarily result in reducing the impact of socio-economic background (Askew *et al*, 2010). Ideally what is assessed would be an integral part of the school's role to prepare pupils for their future. What is planned is not necessarily what is learned or what is retained and this is what teachers need to know to be able to build and develop in a coherent manner, creating a “bridge between teaching and learning” (William & Thoresen, 2009:15). Summative assessment of learning (AoL) systems generally require the pupil to perform on tasks designed to be representative of what is being assessed and success indicates possession of the required knowledge (Ernest, 2011). Standardised testing is commonly used but has limitations such as teaching to the test. This minimises higher-order learning and what is not to be tested is not taught. Also, uncritical use of the results is misleading. This system of sampling what a pupil can do at any one time, which may be different from one day to the next, only tells us what is seems to have been learned and remembered, rather than what might be possible to learn (Orton, 1992). This might be regarded as an over-simplified and flawed method of endeavouring to determine effectiveness of teaching and learning in mathematics teaching as it reduces pupils' mathematical progress to quantitative data. It is a fallacious perception that

human lives can be condensed to numbers and this flawed argument denies that all and any knowledge held about education, its purpose and value is acquired by way of interpretations made through judgements and decisions of information available (Hammersley, 1995).

Outcomes in each setting will vary according to context, history, the individual or group and other knowledge held (Schwandt, 2007). However, standardised testing has the benefit of results that can be empirically documented and aggregated, resulting in a reduction of error through large sample size (Koretz 2008).

To achieve effective assessment requires teachers to acknowledge and understand the subjective nature of learning, in which pupils' understanding reflects the teaching they have received and hence the assessment is subject to interpretation (Romero & Mari, 2011). This is where formative assessment for learning (AfL) becomes a fundamental part of teachers' practice, enabling direct and immediate responses to each pupil and each situation (Black & Wiliam, 1998; Hodgen & Wiliam, 2006). The effectiveness of this in practice was endorsed by Ofsted (2008, 2012). One embedded benefit of AfL is that communication between pupil and teacher makes it possible to create and confirm shared understanding, using every day and mathematical language (Barmby *et al*, 2009). As Turner and McCullough (2004) noted, language has a fundamental contribution to make to the development of mathematical understanding; by using communication and AfL as tools for teaching, ideas and concepts are explained and assimilated. AfL involves children in the assessment process providing opportunities for children to show their understanding and for teachers to make immediate and subsequent adjustments to the next stages of teaching. Despite the apparent disregard of individual differences and needs when planning lessons, in the NCETM (2014) mastery criteria, they also state that formative assessment is to be used. AfL enables the teacher to determine and deal with any errors and misconceptions that arise during the lesson as well as using questioning to make regular assessments so that no-one gets left behind (Barmby *et al*, 2009).

2.8 Inequities

Ofsted (2012:10) recommended more prominence for integrated problem-solving and investigation and that greater challenge was needed for the most able with a need to secure “basic knowledge and skills for the least able”, restating the view proposed by Krutetskii (1976), discussed earlier. This may be because learning relational understanding and application cannot be a short term objective and hence it will not be easy for teachers to show progress for slower or less able learners (Hughes *et al*, 2000). Additionally, inequities in the system, five of which are noted in *Fig 1*, may place additional barriers to pupils’ progress.

- The best teaching tends to occur for those pupils about to undertake external assessments (Ofsted, 2012) (although they do not define ‘best’);
- Younger and less-able pupils are often allocated to teaching assistants or less experienced teachers (*ibid*);
- Less visibly motivated pupils are often deemed less able by their teacher and those pupils who are willing to engage are seen by their teachers to be confident and their abilities are judged accordingly, giving a skewed and limited view of their experiences and potential (Hardy, 2007);
- The socioeconomic background of the pupils may determine their perceived abilities and those from the upper classes are given more opportunity for a problem solving , hermeneutic approach whilst those deemed less able, from the lower classes, tended to have a more rote learning diet (Brown, 2010);
- There is evidence that more highly qualified teachers tend to teach in higher socio-economic schools and create higher attainers (Askew *et al*, 2010).

Fig 1: Five inequities in the system

Hughes *et al*, (2000) recognised that transferring mathematical knowledge acquired in one context to problems posed in another is difficult; not only does the pupil need to build on what

they know but also know how to use what they know in unusual or unexpected situations.

Pupils struggle to understand and teachers struggle to teach, needing approaches that include well-planned activities that are meaningful, relevant, motivating and real-life coupled with teacher ingenuity and originality. As Hughes *et al* (2002:2) stated, “application is more complex, deeply rooted and resistant to solutions than many people realise”. This difficulty compounds the complexities of determining ability and potential. Schools hold a responsibility to pupils to ensure they get good quality teaching at all times; however these factors will contribute to perpetuating the differences and inhibiting change and social mobility (Askew *et al*, 2010). Aldrich (2005) incorporated the personal element including value, concern and respect along with enthusiasm and the ability to inspire. Alexander (2004) proposed his vision of education to pursue high-standards for all, with breadth and humanity, requiring both pupils and teachers to be prepared to take on challenges and risks.

2.9 Developing as a professional

Schools need to be proactive in challenging the status quo as teaching with unquestioning conformity to current practices may limit the teacher’s potential to consider alternatives (Bjuland & Jaworski, 2009). One important factor within this is teachers’ own emotions and creative engagement with learning and their pupils. Teachers’ educational, cultural and personal experiences will have contributed to the formation of their identity as teachers of mathematics, which Hanley and Darby (2006) believed is not fixed. Indeed, Mooney *et al* (2014:78) observed that “a teacher who has had to work and think hard to overcome their own lack of understanding and mathematical self-esteem can often prove to be a more empathetic teacher than one who has rarely had to question their own mathematical understanding”. Thus it is possible that teacher identity will change through adjusting to accommodate the changing world in which they need to function. However, teachers establish customs and practices that make life manageable and these routines can inhibit and limit possibilities and act as a barrier to progress. Indeed, ‘habit’ can stand in the way of

development and advances in new ways of thinking (Mason, 2004). Hence change will only occur if the teacher subscribes and has personal agency in the process.

This is further complicated as, within this, there are the values that the teacher brings, including their beliefs about their pupils (Askew *et al*, 2010). It is possible that in the same school two teachers may hold very firm but very different or contrary views on a particular issue in mathematics education (Orton, 1992). Each has to respect the other's perspective, acknowledging that although teachers' approaches to theory may not be evident, they may be deduced from their actions (Turner & McCullough, 2004). Teachers teach according to what they believe will work, based on factors such as experience, intuition or "even wishful thinking" (Orton 1992:1). Hence a teacher's adoption of a pedagogical approach to teaching mathematics will arise from beliefs (or other hidden agenda) as to what is most effective (Llewellyn, 2012). Additionally, teachers who have high expectations of their pupils through a professionally held belief will have pupils who achieve better than those of a teacher who does not hold these beliefs (Krutetskii, 1976; Pendlington, 2005). The excellent teacher possesses knowledge and understanding of the diversity of the pupils they will meet and consequently is able to engage intellectually, actively and creatively (Wragg, 1993). Another knowledge that teachers possess is tacit (Wenger, 1998) or 'guild' knowledge, which Sadler (1989) described as that which a teacher may not be able to articulate, resulting in qualitative judgements shared with others in the profession.

Provision of long term CPD that addresses poor or inconsistent mathematics subject knowledge and pedagogical subject knowledge, with a view to enhancing teacher confidence and attitude, is central to improvement (Williams, 2008; Ofsted, 2012). One role of staff development is to provide opportunities for improving mathematics teaching through endeavouring to create better understanding of the subject (Turner & McCullough, 2004). As a result, teachers should develop improved confidence and so enable more effective teaching. Alexander (2004) supported the principle of continuing teacher education to achieve

excellence, from the start of initial teacher training and throughout a teacher's professional life. Therefore in addition to basic and functions improvement of subject and pedagogical subject knowledge, another role of staff development is for teachers to engage with research both as receivers and initiators. De Kock (2010:14) noted that by this means that teachers will, through research and "investigatory attitude [...] develop excellence in their teaching practice". This was supported by De Geest (2011:78) who found a range of benefits including widening views, "deep thinking", "confidence" and "courage". This was the impetus behind the creation of the Mathematics Specialist Teacher (MaST) programme, taught and validated by HEIs, in which each school has one teacher (or access to one) who then undertakes CPD with colleagues and creates whole school approaches and policies relevant to the school's context (Ofsted, 2011). It is argued that in-school CPD provides cost and time efficiencies (Williams, 2008), a strategy intended to raise the "status and credibility" of the CPD (De Geest, 2011:78). Of particular concern to Ofsted (2008) was the reducing focus on mathematics specific CPD. They identified the reason for this as the drive by teacher and school towards achievement in tests, implying a particular vision of primary mathematics.

2.10 Educational ideologies

Ideologies are useful tools as they provide an overview of the underpinning beliefs and principles of the groups concerned (Meighan, 1989). Pittenger and Gooding (1971), Ernest (1991, also citing Williams, 1961), Halsey *et al* (1997), and Matheson (2004), are among those who have presented the key characteristics of a range of educational ideologies. Perceptions of excellence in teaching will therefore vary according to the ideologies to which the group subscribes. For example, in the early twentieth century, the "industrial trainer" ideology held that the child was an "empty vessel" requiring the teacher to fill them with appropriate utilitarian facts (Ernest, 1991:139).

Trends in education cause shift and change, reflecting the political and hence socioeconomic situation of each period. Consequently, ideologies may merge and separate, become time-

expired and cease to exist. Within this, teachers endeavour to create their identity. Meighan (1986:185) defined educational ideology, stating that it is “the sets of ideas and beliefs held by a group of people about the formal arrangements for education, specifically schooling” and how it should therefore be structured and delivered. To illustrate this, he provided a breakdown of the component theories that contribute to an educational ideology. Ernest (1991) criticised this view as too limited as it ignored the central epistemological and ethical beliefs from which it arose and therefore he determined that these were secondary elements. They certainly provide a sound set of summarising fundamentals to act as practitioner guidance but to Meighan’s model, Ernest added some primary elements. The combined outcome is summarised in *Fig 2*.

Primary elements (Ernest, 1991: 134):

- Epistemology
- Philosophy of education
- Set of moral values
- Theory of the child
- Theory of society
- Educational aims

Secondary elements (Meighan, 1989:185):

A theory of:

- knowledge, its content and structure
- learning and the learner’s role
- teaching and the teacher’s role
- resources appropriate for learning
- organisation of learning situations
- assessment that learning has taken place
- aims, objectives and outcomes
- the location of learning

Fig 2: Components of an ideology of education (summarised from Ernest, 1991; Meighan, 1986)

Ernest's inclusion of a philosophy of education is worthy of note and his principles for a philosophy can be generalised into four main aspects: "the philosophy of the subject"; "the nature of learning"; "the aims of education"; "the nature of teaching" (1991:xii/xiii). Although, as Ernest acknowledges the duality of philosophy as an open minded view and an ideology is closed, reflecting generally political, entrenched views he concluded that philosophy might be considered as the central or originating tenet of an ideology.

The aims of primary mathematics education are the vehicle through which the ideologies are expressed, organised and enacted (Matheson, 2004). As these filter down from policy makers to the school, the role of the teacher becomes central in interpreting the aims for their class and individual pupils so they can deliver excellent teaching as the means to achieve those aims. Meighan (1986) noted that ideologies may be located in various levels such as the class, the school and wider and that these will impact on the teaching experienced. As a result, excellent teaching will be that which interprets the aims drawn from the ideology to provide the desired education. The research of De Kock (2010) into teacher excellence shows that a teacher's identity is informed by their personal philosophy and ideology, thereby not resting at school or wider level. The outcome of this is that to achieve excellent outcomes and so meet the needs of the individual and of society, the teacher's individual professional identity is central.

2.11 Examining theoretical perspectives

The intention in this section was to find one theorist who would provide a view useful to discussion of the research findings. Those mentioned in the review of the literature on education in general and primary mathematics in particular provided the starting point. Seven emerged as prominent and it could be seen that there is a clear chronology to the times when they propounded their theories: Foucault, Bourdieu (mid 1970s to mid 1980s); Bruner, Holland *et al*, Wenger (1990s) with Bandura spanning from mid 1970s to mid 1990s and Bronfenbrenner in 2004. These theorists referenced each other's work so as a consequence it

became evident that more than one theorist had relevant aspects. To clarify and articulate the interrelationships, connections, uniqueness, particular slants and differences key aspects of each were noted, cross-referenced wherever they occurred and then recurring emerging themes were highlighted (see table in appendix 1). Cross-consideration and analysis of these themes and the theorists gave rise to the schematic in *Fig 3* which shows overlaps and strength of association in the context of my study.

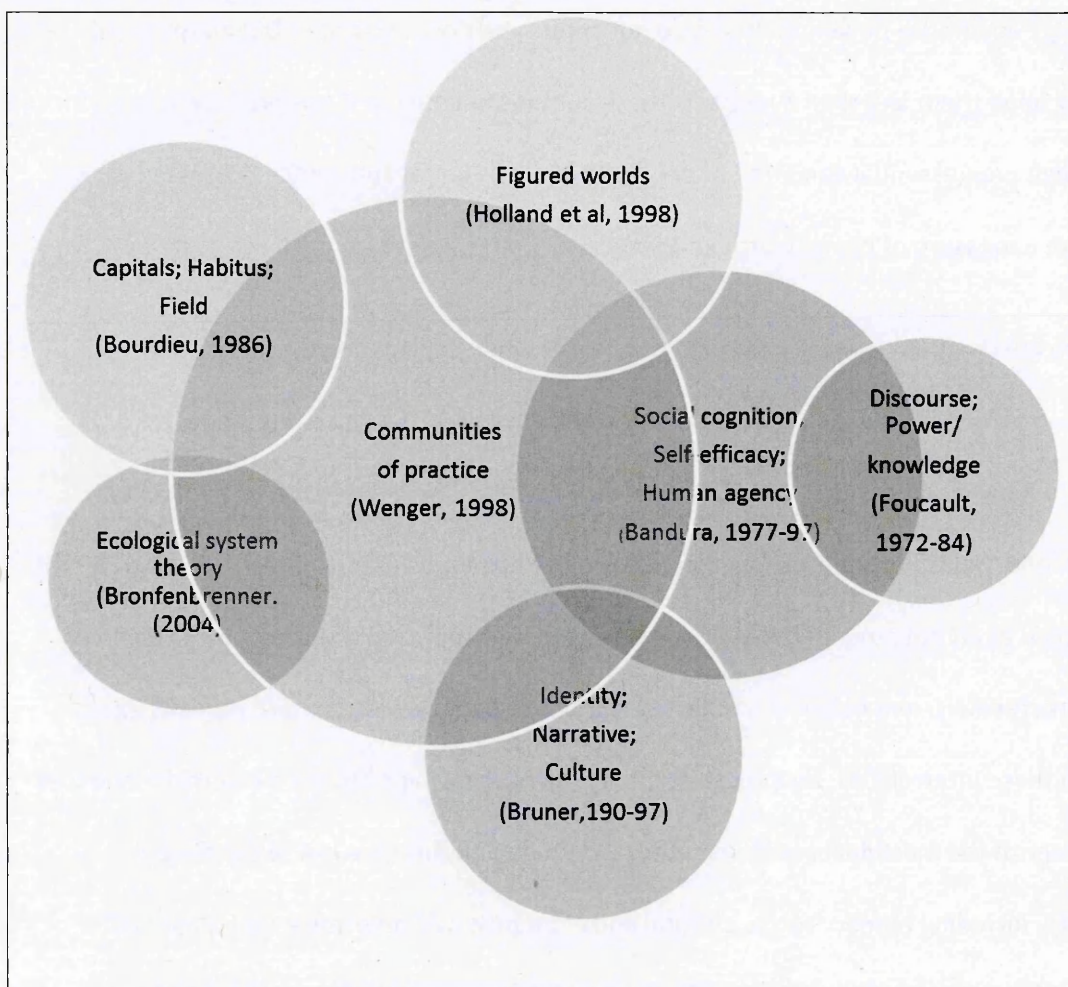


Fig 3: Interconnections of 7 theorists, for the purpose of this study.

As can be seen in *Fig 3*, and argued below, Wenger’s theories emerged to provide the favoured framework for this study. With an acknowledgement of the potential implications of trivialising or over-simplifying, what follows is a brief overview of each of the theorists around the themes of culture, community, knowledge, learning, agency, self-efficacy, identity, self and power – particularly pertinent to mathematics teaching. The review culminates with Wenger’s

thinking which, as the chosen theoretical framework, receives more extensive consideration to provide a rationale for his selection.

Foucault (1975, 1976, 1978 and Ball *et al*, 2013) took the approach that knowledge and power are reciprocal and concomitant. From the start of life, the child's development is directed by those with the power to do so and the knowledge is only passed on and added to by those in power. People without knowledge are told how to act and who they are by those with knowledge and hence power. Cultures do not create their own identities but adopt those imposed upon them and then eventually these cultures become as if self-produced.

Knowledge is an essential condition of being and the amount of knowledge possessed is therefore a measure of being, worth and power.

Bourdieu (1971, 1986) used a constructivist analysis when considering power relationships within and across cultures. Human actions result from interactions between thoughts and actions of individuals and the world in which they operate. He devised the terms 'capital', 'habitus' and 'fields': capital was borrowed from the economic usage meaning something that is produced as an outcome of human endeavour; habitus represents subjective dispositions and characteristics; and field is the objective culture or social world in which humans exist. Through these interrelated, reciprocal elements the relationships between external influences and agency of the individual are illuminated. Bourdieu held that the capitals a person possesses, including human, social, cultural and economic, will determine their position through life; consequently education offers possibilities for adjusting the levels and hence balance of the capitals and so creating potential for social mobility.

Bruner (1990) was clear that individual identities, the 'self', is a construction that arises through the human characteristic of reflexivity, both from culture and its history and into culture, by which we then may control the present. However, he warned that this resultant 'agency' presupposes choice which is not necessarily always present. Education is one facet of a culture that provides the opportunities to find identities within that culture.

Bandura (1977, 1982, 1997) stated that human behaviour results from continuous and reciprocal interactions between a range of factors including cognition, environment and behaviour. People are not passive responders but active agents generating impetus and creating a necessary dynamic through which 'self-efficacy' or agency may thrive. The scope of this agency evolves from the obstacles to change a person feels they can surmount. This gives rise to the opportunity for individuals to be the principal agents in their own evolution and hence to changes within their cultural group. However, misjudgement of self-efficacy may produce adverse consequences resulting in a reduced perception of one's agency and so inducing reluctance to take further risks. Bandura coined the phrase 'social cognitive theory' which allows the self to be both agent and object in which people are both products of their cultural environment and producers. This provides the means for collective efficacy if a group's interests have shared purpose which does not necessarily mean that all within that group agree. Therefore, by living in cultural groups, people will have shared values and practices that may well differ from those of another group. All factors, internal and external, influence learning to a greater or lesser extent, with each case being individual.

Holland et al (1998) created the term 'figured worlds' within which social position and relationships exist and have values attached. These gain shape from and give shape to the participants who develop and change through activity. Through this socially constructed activity identities are formed which are both relational and positional, "sociocentric or interdependent" and "egocentric or independent" (p30), an ontological duality that presents a paradox of how can someone break the bonds of the culture that they have created (Clammer et al, 2004). An integral part of this process is human agency (the capacity of people to act upon their world) which is limited when the individual has little power. This may give rise to swings between commitment and disenchantment which in turn will shape how a person responds to their own world and hence to others (Martin, 1992).

Bronfenbrenner (2004) devised four nested systems: *micro* (family, classroom); *meso* (two micros interacting); *exo* (external, indirect influence such as parent, workplace); *macro* (larger socio-cultural context). He later added *chrono* (the evolution of the other four over time). Within these systems the individual will contribute to development through the synthesis of active person and active contexts and this constitutes the driving force of human development. Humans have the capacity to grow and adapt and we create environments with peers that shape human developments and this agency makes us active participants in our own development along with the influence of relative power and stability. Influences external to the community have very little effect on the fundamentals of human behaviour, suggesting that the strength of the impact of a culture is such that development will continue in much the same way, regardless of external changes.

Wenger (1998) determined that learning, meaning and identity are formed by and give form to individuals, communities and organisations through a synthesis of actions between the person and their context through active social engagement. Arising strongly from this is the certainly he held that learning is embedded in the history and hence culture of the community within which it takes place and to which the individual will then contribute, thus creating 'communities of practice'. There are many communities to which children and teachers belong but to be a community of practice, Wenger required the presence of three elements: domain (a shared interest that defines identity in which shared competence is valued); a community (with relationships and interactions); practice (sharing practitioners, shared repertoire for practice). Combined and developed, these three elements contribute to the nurturing and development of the community.

Noting that these three elements need to be present, Wenger (1998) was concerned with the means by which learning takes place and created a graphic (*Fig 4*) to show causality of the elements he had determined to learning. He posited four premises: that humans are social beings; to possess knowledge is to be competent; knowing to be acquired through

participating in active engagement; meaning is produced by learning. Learning is inherent to human nature and through social participation and practice is the vehicle for the evolution of customs into which newcomers are inducted.

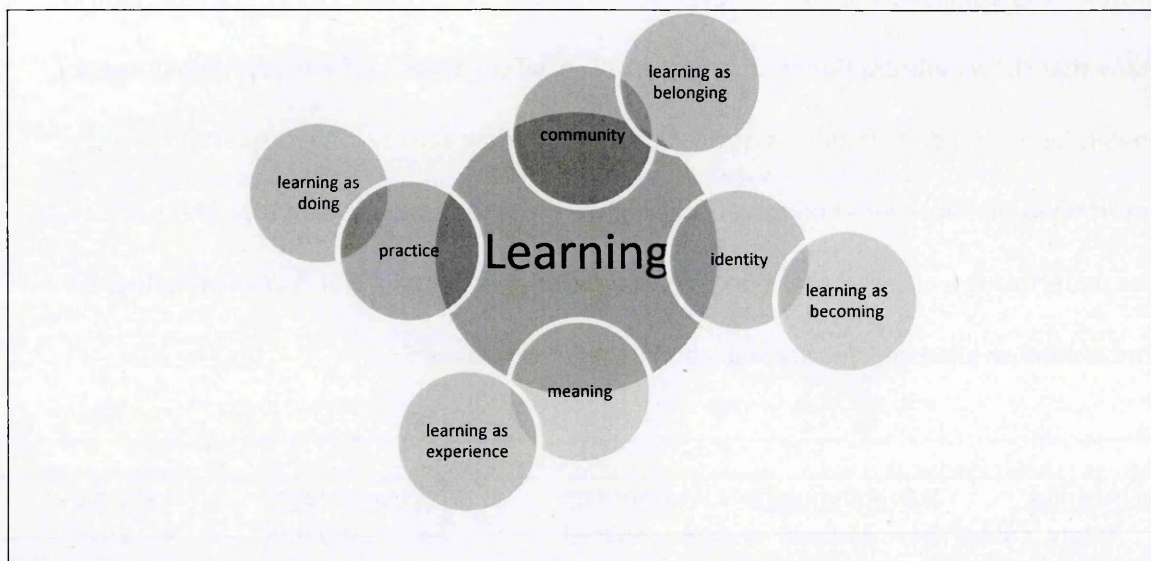


Fig 4: "Components of a social theory of learning", (adapted from Wenger, 1998:5)

Learning develops and transforms identity, providing structure and meaning. It endows individuals and communities with energy and power that is both productive and reproductive within a social system of shared resources. An individual's identity arises from a social formation of the person and is a marker of membership of the community to which they belong.

However, the apparent egalitarian, harmonious view of a community of practice does not deny the influence and impact of power as "power and learning are intertwined and indeed inseparable" (Wenger, 2010:9). He proposed a theoretical perspective on identity that he called 'situated expertise'. This drew on the social interactions between people with a focus on agency and form which he concluded that communities of practice are created by proactive, rather than reactive, responses to power. Through acquisition of identity and "economy of meaning" (*ibid*), teachers gain their 'guild' knowledge (Sadler, 1989), constructed and possessed through agency, providing measures of competence, power and stability. Through this the individual gains agency, self-efficacy and self.

The purpose of this study was to determine the views of those practitioners who have responsibility for the delivery of mathematics teaching in primary schools. Therefore it was important to determine a theoretical framework that would enable analysis within that context. Although discrete features of all seven theorists are evident, there is a repetition in many that shows subscription to the theories of social cognition, self-efficacy, human agency, power, identity and communities of practice. The deciding activity in the exploration that determined that Wenger’s community of practice theory was be most appropriate to the study was undertaking a collation of Wenger’s social theories of learning which draws together his conclusions on practice, identity and learning, tabulated in Fig 5.

Practice					
<u>As meaning</u> <ul style="list-style-type: none">Negotiation of meaning involves: Participation & Reification, which form a duality	<u>As community</u> <ul style="list-style-type: none">Mutual engagementJoint enterpriseShared repertoire	<u>As learning</u> <ul style="list-style-type: none">Shared memories & historiesDiscontinuityNewcomers; generational discontinuity are also continuity.	<u>As boundary</u> <ul style="list-style-type: none">Continuity across & linkingCoP as sources of boundaries & creating connectionsSocial landscape	<u>As locality</u> <ul style="list-style-type: none">One communityConstellation of CoPInteraction between the local & the global	
Identity					
<u>In practice</u> <ul style="list-style-type: none">As negotiated experienceAs community membershipAs learning trajectoryAs nexus of multimembershipAs relation between the local and the global		<u>Of participation and non-participation</u> <ul style="list-style-type: none">Non-participation as formation of identity<ul style="list-style-type: none">OutsiderPeripheralMarginalised	<u>Of belonging</u> <ul style="list-style-type: none">EngagementImaginationAlignment	<u>Identification and negotiability</u> <ul style="list-style-type: none">EngagementImaginationAlignment	
Synopsis of learning (pp226-228)					
Learning is inherent in human nature	Learning is first and foremost the ability to negotiate new meanings	Learning creates emergent structures	Learning is fundamentally experiential and fundamentally social	Learning transforms our identities	Learning constitutes trajectories of participation
Learning means dealing with boundaries	Learning is a matter of social energy and power	Learning is a matter of engagement	Learning is a matter of imagination	Learning is a matter of alignment	Learning involves interplay between the local and the global

Fig 5: Social theories of learning, (collated from Wenger, 1998)

It was possible to see how these related to the principles espoused in much of the foregoing literature and therefore, a theoretical framework that draws on Wenger's situated cognition and sociocultural views of learning seemed to be appropriate for this research.

2.12 Conclusion

This review of the literature has examined a range of aspects relevant to the research undertaken with key themes arising. It can be concluded from the literature that education should have more than one purpose in meeting both the needs of society and of the individual. However, the latter is largely subsumed within the politics of directing and controlling society. There has been both adaption and stasis in the nature of education whilst society has experienced great change. It is evident that attitudes to, and confidence in, mathematics have direct implications for teachers and pupils with consequential inferences for teacher knowledge of the subject and pedagogical subject knowledge, both of which are necessary. Mathematics in primary education is intended to ensure children can contribute to the economy in the future through knowledge, skills and cognition, yet the curriculum presents mathematics as an unnatural series of discrete parts. This exemplifies the dissonance between policies and research which has consequences for subsequent recommendations for practice. Pupils who are pro-active participants are likely to be motivated and regard mathematics for its intrinsic value. While short-term teaching to meet extrinsic targets may be successful targets, the negative impact on the motivation of pupils cannot be ignored. Endeavours to measure outcomes of primary mathematics teaching rely predominantly on quantitative means. Whilst these are flawed they are useful methods with qualitative alternatives lacking viable tangibility. Inequities exist and teachers' actions can become passive second nature, but CPD can contribute to reducing these, improving knowledge and to enhancing the quality of teaching. Education policy and practice through the last century were informed by different ideologies to provide the desired education. These ideologies have informed a range of views of the teacher from a functional practitioner enacting competencies to an intellectual,

reflective academic. The views of several theorists may be considered relevant within consideration of primary mathematics education with Wenger emerging as most pertinent.

There are three key areas not addressed directly in the literature. Although much is written about the role of the teacher, this does not consider the nuances of the individual personal and professional identities of teachers and the resultant impact. The second gap is that although the literature uses the word 'excellent' and 'excellence' it is explained by usage and association rather than being directly defined. The third is an absence of effective measures of long-term impact of past strategies for teaching mathematics in primary school. This study will endeavour to improve the first two whilst the third will need to be the subject of further research.

Chapter 3 - Methodology, design and methods

This chapter explores the methodological stance that underpinned the study in pursuance of the research aim, the design considerations and the methods adopted to address the research question. It starts with the research aim, research question and the nature of educational enquiry. The chapter continues with the methods of sampling, data collection and analysis for the preliminary study and then the main study. The last part considers the role of the researcher, ethics and ensuring rigour in the research.

3.1 Research aim

As noted in the introductory chapter, the aim of this research was to explore conceptions of the words 'excellent' and 'excellence' when used in the context of primary mathematics teaching. This arose from an increasing awareness of the paradoxes encountered by teachers at all levels of education who create their identity through a need to reconcile their personality and life stories, their professionalism and the political agenda. The intention in undertaking the research was that eventual outcomes would contribute to knowledge in the field of teacher education. It was anticipated that it would illuminate many contributing issues through determining the views of those responsible for creating excellent teaching, thereby offering ways forward to educators and policy makers.

3.2 Research question

This research had a single question: 'How is excellence in primary mathematics teaching perceived by primary teachers and mathematics teacher educators in England? Throughout the research process other supplementary and additional questions emerged. These were concerned with: the role of the child; the impact of respondent biographies; the importance of subject knowledge; the necessity for excellent teaching. However, these questions were not originally formulated to support the pursuance of answers to the initial question but came

about during the process of conducting the research. Therefore they are not addressed discretely but are embedded within the answers to the single original question.

There cannot be any assumption that the ontological and epistemological stances held by the researcher are those held by the respondents and vice versa. In this study the contributions of the respondents are examined through a sociocultural framework to include not only their perspectives but how they were gained. As emerged, the mathematics teaching they espoused typifies a social constructivist stance, considered later.

3.3 Educational enquiry

One part of the preceding literature review considered how to ascertain the value, purpose and success of education and the difficulties that arise when endeavouring to quantify the effectiveness of teaching and education. The literature review raised questions about not only the nature of excellence in primary mathematics teaching and how is it measured, but also who decides what makes an excellent teacher. This research approach required some fundamental assumptions about the world being studied (ontology) and what knowledge was intended to be gained about that world (epistemology), which, within the field of educational enquiry, led to the interpretative paradigm (Taber, 2007). Far from being a “self-justifying activity” (Atkinson, 2005:17) this approach made it possible to endeavour to depict the respondents’ views of social reality. As the paradigm is concerned with how the social world is interpreted, understood, experienced or produced (Denzin & Lincoln, 2011; Mason, 1996) it was possible to make suggestions of possible relationships, causes, effect and dynamic processes. Maykut and Morehouse (1992:12) usefully summarised the characteristics of the interpretative perspectives (in contrast to the positivist), providing an ontological perspective of “multiple realities [...] with sociopsychological construction forming an interconnected whole” in which the knower (or agent) and the known (or object) are symbiotic. This is also a characteristic of socioculturalism.

For this research into excellence in primary mathematics teaching, a useful perspective was one offered by Denzin and Lincoln (2013a) who discussed Eisner's (1991) view that the methodology of educational enquiry contributes in two ways. Not only should the research develop the researcher's perceptive capacity to understand and delve into the educational experience but also the researcher is able then to translate and interpret what they find, such that the body of knowledge about educational phenomena is enhanced. This research required engagement with a range of aspects concerning both children and teachers as learners, acknowledging that learning is an instinctive human trait, taking place through internal and external experiences, and both passive and active engagement (Tedder & Biesta, 2008). In addition, this provided access to the nature of teacher knowledge, both practical and theoretical, how it is acquired and the nature of knowing, contributory components in determining what constitutes excellence in teaching (Fenstermacher, 1994). This granted the means to locate the data inside the personal, social and professional contexts from which they are drawn.

Tedder and Lawy (2009) cited how Bruner established that through telling our stories we create our identities and learn about ourselves. Therefore, the researcher needs to ensure that the social situation of each individual narrative is always acknowledged whilst also keeping to the fore the elements that contribute to the individual's identity. This concept of teacher identity seems central to examining excellence in teaching yet Beijaard *et al* (2004) noted that while many studies consider teachers as practitioners, they found few that examine the nature of teacher identity. Consequently they argued for greater attention to be addressed towards concepts such as "self" and "identity", how they are related and what role they and the context play in the creation of a teacher's professional identity (*ibid*:107). In this context, this investigation into excellence in teaching was timely, given the driving forces of policy making within the political and professional situation current at the time of the study.

The last part of the literature review explored the theorists and their views relevant to this study, providing a paradigm that draws on situated cognition and sociocultural views of learning. Hence the ontology of this educational enquiry was the study of the perceptions and beliefs of excellence in teaching and the epistemology was the study of how to come to know about those things. Crotty (1998) noted that as ontological and epistemological issues tend to merge together they should sit alongside each other so informing the theoretical perspective. He commented that it is not possible to consider construction of meaning without including the construction of meaningful reality thus with ontology acting as a motive force, epistemology and methodology form a dynamism. Ernest (1998) and Mason (1996) provided a slightly different view, considering that epistemology is derived from ontology. The interpretative paradigm emerged as an appropriate approach. This was founded on basic assumptions about the nature of the phenomena being studied, the nature of the research process and the kind of knowledge to which it can lead.

A corollary of adopting this paradigm was deciding whether to adopt a constructivist or a sociocultural theoretical framework through which to view the findings. By collating theoretical perspectives, it was possible to draw out characteristics of the conceptual frameworks of socioculturalism and constructivism. These features were then compared to determine where they are mutually exclusive, complementary or reconcilable and also where social constructivism fits. Packer and Goicoeches (2000) argued that although constructivism and socioculturalism arise from opposing ontologies (dualist and nondualist), these can be reconciled as complementary. Both stances acknowledge active construction of knowledge through schemata of cognitive activity by individuals and that these individuals participate in and are subject to enculturation into social practices of the local community (Cobb & Yackel, 1996). However, as Cobb (1994) identified, constructivism holds that the cognitive activity of the individual has precedence over cultural and social action whereas socioculturalism maintains the opposite. This comparison is tabulated in *Fig 6*.

constructivism	socioculturalism
Ontology dualist – known and knower are discrete.	Ontology nondualist – known and knower are interdependent, (also interpretive).
How we act as if we are facing an independent world.	Perspective on how we get to that point.
Attends to epistemological processes and structures.	Able to locate in an ontological process.
Gives priority to individual student’s sensory-motor and conceptual activity. Concerned with the quality of individual interpretive activity	Links activity to participation in culturally organised practices. Cognitive processes are subsumed by social and cultural processes.
Complementary and can be reconciled as both perspectives tacitly assume active individual construction as well as participation in and enculturation into social practices.	
Sociocultural and constructive perspectives each constitute the background for the other.	
Learning is a constructive process that occurs while participating in and contributing to the practices of the local community.	
social constructivism	
Epistemology, stability and autonomy relativized to the community of knowers.	
Social mechanism by means of which knowledge is generated and justified.	
View of empirical truth is pragmatic. Has working theories of the world, both explicit and implicit, not beyond the reach of possible revisions. Best regarded as low-level hypotheses rather than facts.	
Knowledge is relative and subjective to the context and experiences of individual and group. Is adaptive, organised and constrained.	
3 types: symbolic interaction, social constructionism and sociocultural constructivism (most to least social).	

Fig 6: Summary of features of social constructivism and socioculturalism, drawn from Cobb (1994), Ernest (1998), Packer and Goicoeches (2000), Penny (2014)

Additionally, the constructivist view represents epistemological processes which are part of learning whereas socioculturalism is located within ontology and the whole process of learning (Packer & Goicoeches, 2000). Thus it may be that “sociocultural and constructive perspectives each constitute the background for the other” (Cobb, 1994:19), linked by social constructivism (Ernest, 1998). There are other variations on these terms, such as ‘sociocultural constructivism’, introduced by Schwandt (2007) as one of three types of social constructivism.

Having examined these perspectives, a sociocultural framework was adopted for analysis although social constructivism had a role to play, as will be seen later.

Therefore, examining the data about excellence in teaching by means of these frameworks gave access to a structure which “mediates between objectivity and subjectivity” (Grenfell & James, 1998:14) enabling intellectual analysis to interpret phenomena and the meanings that teachers bring to their identity (Denzin & Lincoln, 2013a).

3.4 Thick description

For the purpose of this research, the term ‘thick description’ is appropriate (Geertz, 1973; Lincoln and Guba, 1985) as a way of broadening and deepening the construct of the multiple realities of the social world through possibly divergent, never complete data (Flick, 2007). Although only two data collection processes were used, the outcomes from each gave different views by providing first insights into the respondents’ beliefs as they were articulated through talking through and then by a process of collating and consolidating that which had emerged. These two directions of looking at respondents’ views contributed to an analysis that used consideration of the several layers of the culture within which teachers work, breadth and depth in the data was achieved (Atkinson, 2005). By examining excellence in teaching through an approach which encompassed biography, behaviour, beliefs and context, it was possible to evaluate the extent to which the conclusions drawn are transferable to other times, settings, situations, and people (Swanborn, 2010).

3.5 Preliminary study

The research started with a preliminary study into conceptions of excellent teaching. This was undertaken through comparison of three sets of data: analysis of documents from the Department for Education (DfE) (and its earlier versions over the previous fifteen years) concerned with excellence in teaching; collation of four sets of criteria to measure excellence in teaching (Excellent teacher standards (TDA, 2006); proposed master teacher standards from

the Training and Development Agency (TDA, 2011); outstanding teacher criteria (Ofsted, 2009); proposed accomplished teacher standards from the University Council for Education of Teachers (UCET, 2011)) and interviews with seven HEI teacher educators.

The preliminary study served two purposes. The first was to take the opportunity to practise some of the research techniques for educational enquiry to be employed in the main study. This helped highlight potential difficulties of using interviews as a method of data collection. It supported the subsequent research in two ways. First, it provided experience of “the unanticipated twists and turns of the interview process and the complexities of the interviewing relationship” (Seidman, 2006:39). Second, it was a chance to “come to grips with some of the practical aspects of establishing access, making contact and conducting the interview,” (*ibid*) including the opportunity to adjust, if necessary, plans for determining what data to collect and how to go about it (Yin, 2009). Also, through practice and reflection on research design and data collection procedures, this provided both confidence in the techniques and processes and the opportunity to make adjustments and revision. All this was intended to enhance the probability for success in the main study (Bourque & Clark, 1992).

The second purpose of the preliminary study was to gain a sense of direction, to offer a baseline and develop a focus to inform the main study by highlighting useful, relevant premises and establishing some underpinning principles of methodology.

3.5.1 Sampling

The search of the DfE website used the search terms ‘excellent’ and ‘excellence’ which revealed 83 documents that sought to address aspects of excellence in education. Many of these led on to other sources. The sampling strategy used, determined by the constraints of time and usefulness, was to undertake examination of the first 25 documents arrived at through sorting using the ‘most relevant’ setting on the website. The second data source, the four sets of measures of excellence criteria, was chosen as representative of those encountered by teachers and teacher educators. Of the two TDA sets of criteria, the excellent

teacher standards (TDA, 2006) were in use as established practice for assessing progression for a teacher's career. The proposed master teacher standards (TDA, 2011) represented a review five years later and hence were useful to examine possible change in thinking. Ofsted, as a different body from the TDA, presented their view of what comprised outstanding teaching as did UCET who put forward their accomplished teacher standards in response to the TDA master teacher standards. Hence, the four sets of criteria were chosen to provide contrast both over time and across different bodies. In accordance with Newby (2010:251), this is a "specialist group sample", based on the criterion of all being bodies with a remit to hold an overview of quality in teaching and hence in possession of specific and specialist knowledge and expertise.

3.5.2 Data collection

For the document search in the DfE website, the access through electronic means gave advantage of scale, at reasonable time and cost, with the potential for high quality data (Stewart & Kamin, 1999). However, more importantly, as Smith (2008) noted, this examination of secondary sources made it possible to retrieve data that could not otherwise be collected, providing access to what was being promoted by the DfE (and previous iterations) as excellence in teaching. This easily acquired sample provided contemporaneous and historic data which offered the potential to be sorted and analysed against criteria such as document type, target audience and issuing government. This provided a discrete source for comparison or correlation across the documents (Lusk, 1997), which was also applicable to the sets of measures of excellence. The interviews gave the opportunity to acquire experience of managing the process and to cultivate awareness of what the respondents thought and believed (Seidman, 2006). As a result, the main study benefited from the practice of finding meaning and relevance in the views and opinions of my respondents (Newby, 2010).

3.5.3 Analysis

As a source used by social scientists, analysis of documents has the advantage of being unaffected by the analysis undertaken for an enquiry and also that the researcher, by being a remote observer, is not directly involved with the processes, interactions or events by which the data are gathered (Robson, 1993; Jupp, 2006). There are other considerations of document analysis that carry implications for the researcher and the nature of the conclusions that may be derived when sourcing data from documents. One is that the documents will have been produced for a particular purpose and this may not be the one for which they were now being analysed (Robson, 1993). Another is that they are “mute evidence” (Hodder, 2012:171) and therefore cannot provide additional contextualisation. However, although documents cannot actively contribute to the interpretation being made, they generally do not stand alone. They relate and connect with others, so allowing broad views into meaning (Atkinson & Coffey, 2011). The range of documents used was determined by the use of a search engine on the DfE website and therefore reflected the briefs of the owners of the site and the social worlds within which the documents were produced.

The method of analysis of interviews is discussed in detail later in the main study (section 3.6.2). The same analysis techniques were used for all three data sources in the preliminary study, intended to give an overview of themes or prominent commonalities. It is not possible for the researcher not to interact with the data and this continuous evaluation and processing may be considered as one of “three concurrent flows of activity” (Miles *et al*, 2013:12). The other two are data condensation and data display and these were deployed for the overview analysis undertaken on the preliminary study data. In this case, the data condensation occurred as an outcome of data display by which means the researcher is provided with a different view of data to enhance analysis (Miles *et al*, 2013). The tool used (www.wordle.net) took a piece of text and displayed it such that words used with higher frequency were shown proportionately larger than those used with lower frequency, forming a word cloud (Feinberg,

2011). This created a visual data reduction, rather than condensation, of which Miles *et al* (2013) suggested, implies loss or weakening of content, whereas condensation concentrates and strengthens the data. Although Miles *et al (ibid)* acknowledged data display as a powerful means of seeing the data, it might have led to simplistic or fallacious conclusions through the naive device of attaching significance to the frequency of word occurrence without reference to the context. The visual sense of dominance and priority is informative but cannot be taken without consideration of the wider backdrop of the original data sources (Denzin & Lincoln, 2013b). This was confirmed when using data display in the preliminary study and it was decided not to use it for the main study.

The findings from the preliminary study were not analysed beyond data display of each of the three groups of data. However, what emerged was that the highest frequency words could be considered to possess some key characteristics attributable to excellent teaching. These were different overall for the three groups although there were some recurrences; for example, 'knowledge' featured in both the measures of excellence and from the HEI teacher educators but was not apparent as prominent in the DfE documents. The teacher educators acknowledged that there were elements of the craft of teaching that were implicit and embedded in practice, not necessarily easy to articulate; the nature of the documented statements of the other two sources meant there was not access to this kind of thinking. It was also possible to derive the actions and people necessary to ensure implementation of the key characteristics which were enacted through actions and people. Again, the measures of excellence and HEI educators presented similar views and the DfE documents different; of note was the absence of people in the considerations of achieving the aims. These overview outcomes of the three data sources, highlighted through data display, are shown in Fig 7. Had this been a pilot study then analysis in greater depth would have been appropriate and necessary to probe into the meanings behind the overview presented here. However, as a preliminary study, it had served its intended purpose: to support the subsequent research by

providing experience of interviewing, from establishing the respondents to conducting the interview; to provide the opportunity to make adjustments and to offer a baseline and develop a focus for the main study; to enable reflection before the main study (Seidman, 2006).

Measures of excellence	DfE documents	HEI teacher educators
<u>Key themes:</u> <ul style="list-style-type: none"> Professionalism Collegiality Knowledge Experience <u>Actions:</u> <ul style="list-style-type: none"> Teaching Learning <u>People:</u> <ul style="list-style-type: none"> Pupils Teacher 	<u>Key themes:</u> <ul style="list-style-type: none"> Commitment Improvement Effectiveness Impact Quality <u>Actions:</u> <ul style="list-style-type: none"> Management/Leadership Achievement/Attainment <u>People:</u> <ul style="list-style-type: none"> (absent) 	<u>Key themes:</u> <ul style="list-style-type: none"> Interrelationships Thinking Knowledge Embedded, understood, implicit <u>Actions:</u> <ul style="list-style-type: none"> Teaching Learning <u>People:</u> <ul style="list-style-type: none"> Children Teachers

Fig 7: Findings of preliminary study highlighted through data display

3.6 Main study

3.6.1 Sampling

The workplace (as for the preliminary study) provided the starting point for the sample of those involved with primary mathematics education for the main study. My professional access to lists made it possible to invite expressions of interest from all members of the groups to be represented in the sample on the basis of knowledge of their typicality, so they would meet the particular requirements of the study. Therefore, the respondents to be studied were drawn through a purposive, specialist sampling method process, reflecting what was used in the preliminary study, using recommendations, professional knowledge, volunteering and ease

of access (Cohen *et al*, 2011; Yin, 2009; Newby, 2010). The approach and their agreement were achieved through email and personal contact, supported by a research protocol.

The sample was drawn from four groups representing four stages of professional involvement with primary mathematics teaching. Consideration was given to a wider sample population that might have included children, parents, school governors and policy makers such as local authority advisors as their views would have added breadth to the opinions available for analysis. However, the population chosen for this study represented a starting point in the examination of the question of excellence in primary mathematics teaching. This population provided a focus of the important players in delivering teaching and offered the possibility of a baseline for further research with other interested groups. This potential is considered in the conclusions to this study.

The sample achieved comprised: student teachers (2); experienced teachers embarking on becoming Mathematics Specialist Teachers (MaSTs) (2); MaST graduates (3); primary mathematics HEI lecturers (3). The HEI lecturers and the MaSTs were interviewed once. As the student teachers and the teachers were both starting their courses, they were interviewed more than once to gain additional insights into change or constant perspectives over time. This resolved itself as follows: one student teacher interviewed three times (at the start of the course, 6 months later and a year after that); the other student twice (as she withdrew from the course); one teacher twice (at the start of the course and a year later) and the other teacher just once (as he withdrew from the course).

Fig 8 shows for each respondent their role at the time of data collection, length of experience in teaching and the number of interviews contributed as explained in the methodology chapter.

	ST1	ST2	MT41	MT42	MT11	MT12	MT13	MTT1	MTT2	MTT3
	Mature, part-time Primary PGCE students		Primary teachers embarking on mathematics specialist course (MaST)		Graduates of MaST with managerial responsibility for mathematics in primary schools			HEI senior lecturers with roles on UG & PG primary ITE and PG CPD including MaST course and MAEd		
Years of experience in teaching	10 (over seas non QTS)	0	13	10	21	9	27	16	14	23
Number of interviews	2	3	1	2	1	1	1	1	1	1

Fig 8: Respondents' level of expertise in mathematics education, age, experience in teaching number of interviews

In all this, my role as researcher and relationship with the respondents was central. They were colleagues and past and present students and regardless of any professional working relationship with them, my status in this research situation was increased as the initiator and manager of the interview. This meant that the usual power relationships and equalities were changed from those that existed through my work (Kvale, 1996). One of the main aspects of ethical consideration to the sampling approach adopted was the potential exacerbation of this power relationship between the interviewer and respondent. When approaching and interviewing participants I needed awareness of the weight of expectations placed on that person (Cohen *et al* 2011) and when talking with professional colleagues, both in university and in school, the asymmetry was an unnatural state.

Acknowledging these potential pitfalls with relationships, my approach to potential participants was careful and open. I started by arranging to present my research intentions to each group (other than the HEI lecturers), asking for interested volunteers followed by opportunity for question and answer. I then made myself available for them to speak with me

further and provided a sample project sheet with detail of their time commitment and my contact details. I was careful to avoid expectations of immediate commitment, allowing time and privacy for reflection and decision making. If they wished they provided me with contact details; however I was clear they could change their mind (Seidman, 2006). The fourth group, HEI lecturers, were directly involved with the delivery of the MaST course and so were present in my presentations to those two groups and therefore had the same opportunities to be involved or not. The endeavour was to establish rapport and empathy but always to maintain, in this context, a professional separation from those who volunteered to take part in the research whilst acknowledging I was a member of the group being studied (Schwandt, 2007).

There was no difficulty eliciting enthusiasm in the first instance when recruiting respondents, neither were there any problems during the interviews. However, a few respondents from the two teacher groups who initially gave a positive response of intent to participate were then unable (or chose not) to pursue this, indicated by either direct contact or by a lack of response to attempts to arrange a meeting time. Care was taken not to use undue and inappropriate persuasion to participate (BERA, 2014) which would have been unethical. It was necessary to bear in mind that even if a potentially ideal respondent had volunteered, that person may later choose not to participate. Therefore, for these few who changed their minds, after I endeavoured to establish contact, their implicit withdrawal was accepted. Additionally, as Seidman (2006) commented, even if the respondent had been persuaded, it was likely that the resultant interview would be an uphill struggle and the outcome may have been less than satisfactory, giving non-representative data. Another point to consider was whether to reuse the one mathematics educator who had taken part in the preliminary study. Bloor and Wood (2006) believed this to be a strength, stating that respondents already familiar with the field under investigation are able to contribute in an informed way and add depth to the research of the main study. However, for this study, it would have meant mixing new and previous respondents, raising concerns that comparisons between them would be unsound. The respondent who had gained a background to the research would have been in a different place

in her engagement with the research question than those who enter the field as new respondents (van Teijlingen & Hundley, 2002). Therefore all participants for the main study were newly recruited.

3.6.2 Data collection

Data collected must provide sufficient evidence to enable “warrantable inferences” to be made when answering the research question (Plowright, 2011:189). He contended that there are three methods of gathering data: observation; asking questions; artefact analysis and for this research one of these was employed, that of asking questions. Interviews are usually one of the main sources of data for educational enquiry (*ibid*) and for this study, there were two outcomes from the interviews – narrative transcriptions and mind-maps. They provided me with ways into the respondents’ social and cultural world, creating access to the knowledge, skills, cognition and emotions that contribute to their identity (Atkinson *et al*, 2001; Yin, 2009). Used flexibly, interviews enabled the respondents and me to work together to gain in-depth understanding of their conceptions of excellence in teaching and how this manifests itself in their particular situations (Newby, 2010). Stake (1995) was clear that he had a preference for finding out what we want to know by observation because in his view it is better to see it, rather than having it reported, but this rather dismisses the depth of data that may be gained through interview. However, he recognised that the interview is “the main road to multiple realities” (*ibid*:64), providing a useful route to information. The principal concern is that by the act of conducting the interview, the interviewer cannot be neutral and therefore the outcomes created may reflect a distorted reality (Yin, 2009). He continued, noting that as interviews are delivered verbally, they represent the thoughts of the respondent at the time and may suffer from bias, lack of clarity and poor articulation.

Interviews may range from the very structured, with little freedom for the interviewer to change or ask additional questions right through to no structure with a free flow of conversation between the interviewer and respondent (Newby, 2010). For the design of this

research, open-ended or unstructured interviews with a single, opening question of 'what do you believe is excellence in mathematics teaching?' were chosen. This gave freedom for the respondents to provide their own insights whilst permitting me as the researcher to pick up and pursue points that arose (Yin, 2009). For these interviews, an approach that Cohen *et al* (2011:377) identified as the "non-directive interview" was adopted which allowed the respondents to take the interview in the direction they chose, with little control from me. This increased the potential for respondent bias and speculation which may, in this instance, be deemed a positive product when exploring identity. Analogously, Newby (2010:345) defined "cognitive or think-aloud" interviews, intended to explore thoughts and ideas, rather than establish facts. These types of interviews have the benefits of reducing researcher bias and giving freedom to gain insights broadly around the subject. In adopting this approach, constraints were not placed on the content and direction of the interviews in which the issues under scrutiny were discussed in a conversational style using prompts where appropriate (Coles & McGrath, 2010; Newby, 2010). By this means, the respondents were encouraged to convey what they wanted in the way they wanted. This approach was subject to potential problems such as respondents who had difficulty articulating their thoughts (Newby, 2010). However, by adopting a collegial and relaxed approach, the occasional stumbles that occurred were overcome or acknowledged as part of what they were endeavouring to express.

The interviews comprised two elements, each of which produced data. The respondents were told of the two stages but not what the second part required until after the first part was completed. The first element was the spoken responses which the respondents gave during the thirty to forty minute interview. The second aspect occurred immediately after the spoken interview when the respondents were asked to draw diagrammatic presentations summing up what they had said. Throughout the interviews, the respondents' thoughts had been evolving so that by the end, they had acquired great personal cognition of their beliefs and some of the reason behind them (Newby, 2010). Therefore the mind-maps allowed the respondents to

demonstrate connections, networks and key principles, having had their thoughts clarified and developed through talking. This was particularly illustrated by one respondent who, through consolidating his thoughts by creating the mind-map (Fig 9), realised that he had re-envisioned how he perceived excellence in primary mathematics teaching and hence had a clear view of how he was going to proceed in his school.

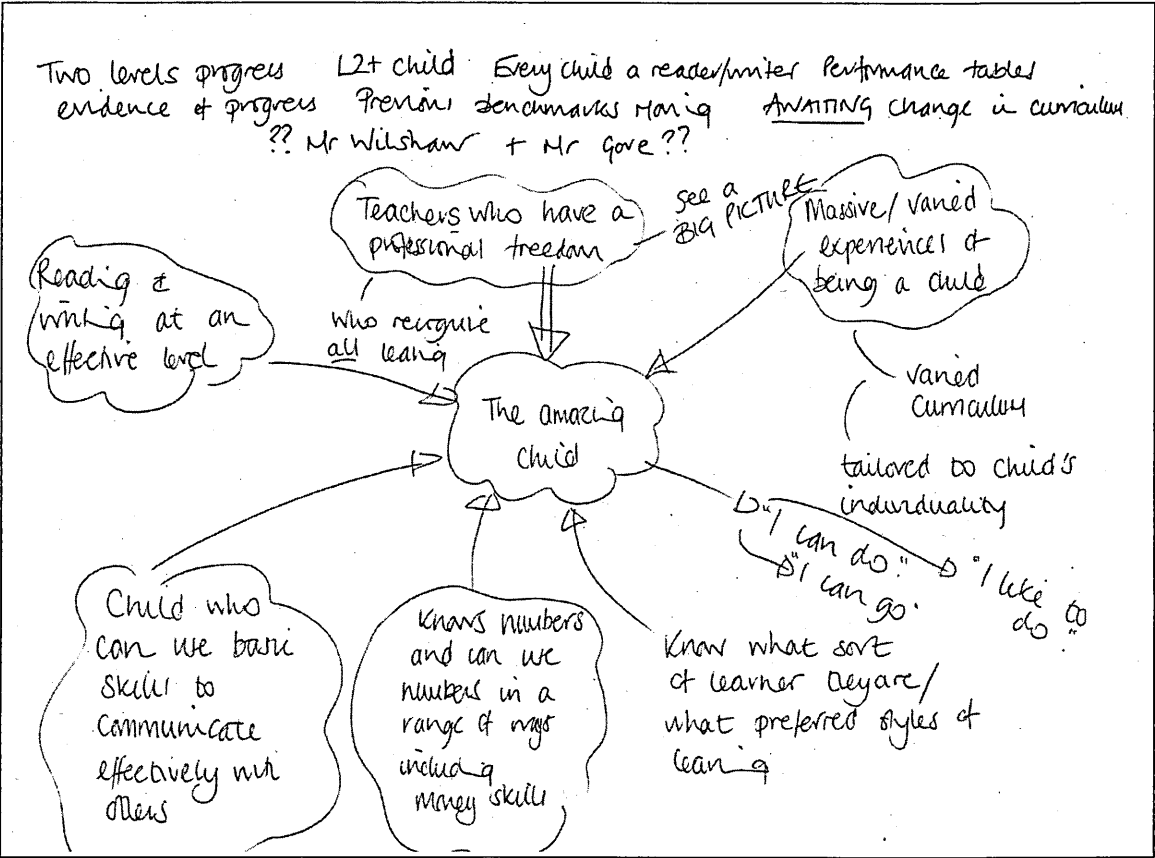


Fig 9: Mind-map example 1

Another respondent found through drawing the mind-map that he had emphasised one point ('take a learning risk') four times in connection with both the teacher and the child (Fig 10)

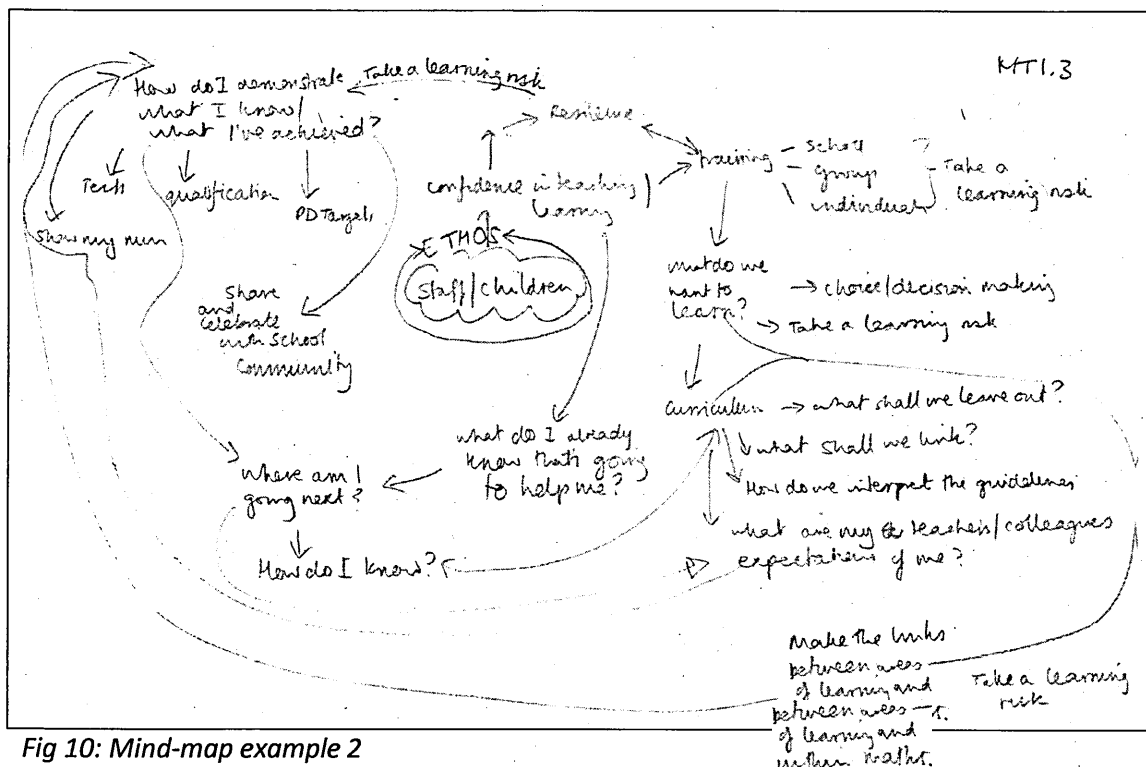


Fig 10: Mind-map example 2

Other mind-map examples are in Appendix 2.

Predominantly the interviews took the form of narratives with “self-contained stories or sub-plots” (Gibbs, 2007:70), drawing on the experiences of the tellers both from their own schooling and as teachers. Gibbs noted several functions of narrative of which the data collection (interviews and mind-maps) addressed three: the conveyance of information; to help define an issue and the respondents’ stance towards the issues; “to structure [...] ideas of self and to establish and maintain [...] identity” (Gibbs, 2007:60). By using the interviews and mind-maps as narratives it was possible to empathise with the respondents’ experiences and so come to understand how they experience their world (*ibid*).

3.6.3 Analysis

The decisions made about how to process and analyse the resultant data were related to the purpose they were intended to serve, that is, to illuminate conceptions of excellence in teaching. Seidman (2006) commented that preliminary analysis based on the hoped-for or expected outcomes was unavoidable right from the start of considering the data to be

collected. Consequently it was inevitable that there was active engagement with the material as it was collected as throughout each interview the respondent's responses were being processed in order generate the next prompt. This meant that interpretations and decisions were being made throughout which, without care, may have impacted upon the direction taken with subsequent interviews. Pertinently, Miles *et al* (2013) observed that the "competent researcher holds these conclusions lightly, maintaining openness and scepticism, but the conclusions are still there, vague at first" (2013:13).

An additional consideration when approaching the analysis was my relationship with both the field under study and the respondents, noted earlier when considering sampling. This required extra vigilance when interpreting the data to ensure that my own ideas and foreknowledge of the field and the respondents were not introduced into the interpretation; only what was in the data was to be interpreted (Laws *et al*, 2003). It was necessary to acknowledge the substantial and close relationships that existed and the potential for ethical dilemmas in interpretation that may have subsequently arisen (Schwandt, 2007). A level of detachment from the respondents was made possible through a time delay between conducting the interviews and beginning the analysis. Working from the anonymised transcripts it was possible to work without an image of the person providing additional perceptions of what I knew of them.

Full audio recording of all that was said prevented loss of detail and limited potential for bias through unwitting selection or the possibility of an unconscious emphasis on points that agreed with expectations or perspective (Cohen *et al*, 2011). In conjunction with this, note-taking and the mind-maps enabled access to verify the data, both during the interview, when reciprocal and instantaneous feedback was possible, and afterwards (Kvale, 2007). By anticipating the possibility of inaccurate recall or interpretation, it was possible to ameliorate any later negative impact, for example in the event that the respondents were unhappy with the transcripts, either because of the revelation of how they spoke or that it failed to say what

they intended (Stake, 1995). The recordings provided a detailed transcription, with the added benefit of being able to return to the interview much later as necessary or desirable (Seidman, 2006).

In considering the best way to undertake analysis of the interviews and mind-maps, I explored the use of a computer-assisted qualitative data analysis software (CAQDAS) programme (AtlasTi) and also the nature of the type of analysis that would be most suitable for the study. After due consideration and some experimentation with the software, I decided not to use CAQDAS. If I had needed to structure and organise a large amount of uniform, homogeneous data it would have been of value as, once initial coding had been undertaken, the programme would have been of assistance in enabling a reductionist approach to be applied to each set of data, relieving some of the laborious nature of the task (Robson, 2002). However it would not have removed the hard work required by the researcher to make sense of the data; further, my data were not extensive and were idiosyncratic to each respondent.

By retaining a manual approach to analysis it was possible to tell the stories of the individuals as well as find the detail, nuances, similarities and differences between them. The interviews provided the unfolding thoughts of the respondents, with ideas, perceptions and beliefs being explored as they emerged. The mind-maps provided the outcomes of the consolidation of these thoughts, permitting elements that had emerged during the interview as having key significance to the respondent. Gibbs (2007) identified that by exploring beliefs with others who are interested we are able to define issues, share experiences, structure how we perceive ourselves and our identity. Labov's narrative elements (cited by Gibbs, 2007) offer useful terms to describe the different and complementary contributions the interviews and mind-maps made to the data. The interviews might therefore be considered as 'orientation' with ongoing 'evaluation' of the first insights into the respondents' beliefs as they were talked through. The mind-maps enriched the interview data through further 'evaluation' as a result of collating and consolidating as well as 'resolution' of what emerged, focussing on what they

perceived to be meaningful and important (Newby, 2010). There was also potential for 'codas' indicating further action by the respondents. Analysis of the mind-maps was undertaken after analysis of the interview transcripts as that was the order of their genesis and involved reviewing the mind-maps for confirmatory, contradictory, additional information and emphasis. This provided more thickness to the data than was available from the interviews alone so contributing to analysis that drew on two directions of looking at the respondents' views.

Data reduction, arising as a by-product of data-display in the preliminary study, was used in the main study as an organisational device that enabled determination of specific points of focus and to isolate salient information and emerging themes in the interviews. Extraneous, distracting or superfluous data were discarded or ignored, creating clarity for subsequent analysis (Miles *et al*, 2013). However this process of dispensing with some or much of the collected information led Denzin and Lincoln (2013b) to warn that reduction is a necessary but regrettable way of distilling data and should be used with caution. A full transcription was used to create documents from which data condensation took place; however even this transcription was undertaken with judgments and decisions made. This included how much of the characteristics and inflection of speech was to be noted. It also did not take account of visual clues and body language, creating a partial record of communication (Kvale, 1996; Denzin & Lincoln, 2013b).

When considering how to go about processing the data in preparation for analysis, two main ways surfaced (Lewin & Silver, 2007): thematic analysis and constant comparative method (CCM). CCM is associated with grounded theory (promulgated by Glaser and Strauss, 1967) in which the data are gathered with no preconceptions of what would be found. CCM enables the researcher to take a more objective approach to the data and is also useful for later data as new themes may emerge which may not be seen if themes chosen at outset are all that are considered. However, for this research CCM was not appropriate as it was not possible to

achieve complete non-engagement prior to active analysis; there were already emerging themes from the preliminary study (as noted above). This study benefited from a less restrictive, reflective approach using emergent thematic analysis (Gibbs, 2007).

The thematic analysis approach used data-driven analysis (themes emerging from the data) when processing and presenting. This was then cross-referencing to concept-driven analysis when considering the data against the literature and theoretical lens (Gibbs, 2007). The findings were initially organised from the perspective of each of the respondents and then collated against the emerging themes, without moving into interpretation. Separating the presentation of findings from the discussion enabled an open mind when looking at themes within and across the data. This then helped to establish priorities without restricting the analysis to solely looking for matters common to all and hence losing sight of what is in the individual accounts (Gibbs, 2007). To support this further, the original transcripts were revisited periodically.

As researcher, my perspicacity and integrity were therefore central to the decisions made when undertaking data condensation, and consequently I chose what I thought would be most useful to address my research aims. When working from a mind-map or transcript, I made analytical choices about how to reduce the data that encompassed personal decisions about what was relevant, critical or weighty (Seidman, 2006). This highlighted that the reduction process was part of the analysis in which I endeavoured not to use the data to test a theory or hypothesis ("deductively") but to allow it to stand on its own merits ("inductively") (*ibid*:100). Kvale (2007:102) referred to a variety of ways to undertake data condensation, depending on the data available and the intended outcomes. From this list the approach taken for the interviews was to use "meaning condensation". Through using this approach, each sentence, statement or even section, was examined as appropriate, summing it up to create the essence of what was said, so pinpointing the embedded key themes and enabling them to emerge. (Seidman, 2006).

Gibbs (2007:63/64) noted that what emerges from the data might be: “events; experiences (image, feelings, reaction, meanings); accounts, explanations, excuses; style”. Processing the data by both emerging themes and through individual stories initially created themes that were merely descriptive but this then led the way to “a more categorical, analytic and theoretical level” (Gibbs, 2007:42). As a result it was possible to discern, whether stated specifically, overtly, implicitly or subconsciously, what is important or significant to the respondents, including illuminating critical incidents. This meant the analysis involved taking something that was descriptive and interpreting what might be implied or something that is thought about or conceptualised by the respondent without being articulated. *Fig 11* outlines the steps taken in the analysis of the data.

1. Several readings of each transcript from one group, condensing the data, annotating for emerging themes and then examination of mind-maps (see Appendix 3 for an example);
2. Creation of 4 documents, one for each group and annotated transcripts and mind-maps of the remaining three groups using the themes that emerged at step 1, noting any additional themes not initially evident;
3. Colour coding each document to identify respondent and collating all under each of the three main themes;
4. Printing and cutting up each in turn and organising in sub-themes under each main heading and then organising these into a coherent account. Returning to transcripts and mind-maps for additional relevant data;
5. Determining findings under these on which they agreed and on which there was no agreement, re-reading transcripts for further insights, and revising as indicated.

Fig 11: The process of thematic data analysis

3.7 The role of the researcher

Although the respondents were given free rein, the interviews were nevertheless “in-depth”, Massarik (1981:202). This meant that as the researcher I was still intensively involved with the process, engaging with the respondents to explore the subject and developing the interview according to any responses to the respondents’ contributions. My role as interviewer was not only to keep the narrative going but also to find the right questions to be able to follow-up potentially interesting comments or statements. This researcher involvement had implications when considering the nature of the data generated by the interview. On one hand, it could be considered as reflecting the views and knowledge of the respondent brought directly from their experiences and daily lives, unaffected by the interview (“*data-as-resource*”) (Rapley, 2001:3). On the other hand it may be that, as part of the process of the interview, the respondent and I created data between us that may not have arisen otherwise (“*data-as-topic*”) (*ibid*). Whilst the intention was to collect the former type of data, the interviews also created data of the latter type, as the nature of the open interview meant that during the conversation, my intervention inevitably raised issues of agreement, consensus or otherwise. However the open-ended, unstructured interview is defined, one point it was necessary to consider was the impact of subjective judgment on when to intervene (Newby, 2010). Newby (*ibid*) identified some reasons for interviewer intervention: to consolidate a point that is being made; to clarify meaning; to expand exploration of the point being made; to invite consideration of consequences or speculate on possibilities; to move on to another point to be considered. Open questions inviting opinions were used as prompts to move the interview along and these could be classified into Newby’s types. When consolidating, questions examples were: “so the management needs a vision?” and “is that one of the markers of excellence?”; to clarify meaning examples were: “how does that work in your setting?” and “is this something you have become aware of recently?”. Examples of questions to extend or develop the point were “what was the impetus behind that?” and “what else do you think

contributes?"; questions to invite conjecture were "why do you think teachers are doing that?" and do you think that will ever change?". Finally, examples of questions used to move forward to consider other aspects were "what else do you think contributes?" and "what else does the excellent teacher provide then, do you think?". Kvale (1996:135) considered the "phenomenological ideal of listening without prejudice" in which the interviewer allows the respondent to talk with little interruption. This I endeavoured to do but also took opportunities to probe, clarify and extend the thoughts, idea and beliefs of the respondents. In addition, by giving the respondent freedom to expand or develop their answer, there was always the possibility that they would introduce an unanticipated thought or direction, prompted by the choices opened by the questions (Cohen *et al*, 2011). Using this approach made it possible for me to invite the respondents to talk about their beliefs, theories and conceptions of excellence in primary mathematics teaching.

It was important, from the outset, for me to be aware that the respondents needed to be comfortable with the situation and what was being asking of them, before they could talk freely about matters that were important or personal to them. They all had their view of me and, even though they had volunteered to take part, their responses would be directed by this view as well as the issues surrounding what would be done with their data and who might see it (Kvale, 1996). Once the interview was underway, it was important for me to deploy appropriate social skills to ensure that, in the closeness of the interview situation, I was always sensitive to the respondent. At the same time, I needed to establish what they thought was of the essence about the subject of the interview (Kvale, 1996; Bassey, 1999). I had a responsibility to create quickly an atmosphere in which the respondent felt free to talk about issues that were personal, including emotions and feelings.

Even in a situation of apparently professional equals, it was necessary to consider that the respondents had agreed to take part as it was a professionally or friendly appropriate thing to do but they may have been pleased, irritated or even frightened to contribute (Bassey, 1999).

This would have impacted on their preparation and readiness for the interview and it may have been the case that the respondent prepared thoroughly or not even thought about the interview, prior to sitting down. By being concerned with the respondent as a person I was able to invite information and responses that would be unlikely to be gained in a more impersonal setting. In turn, the respondents indicated they also valued the research intentions and motive and were keen to respond in depth (Massarik, 1981). Although some still needed reassurance that they were providing what was wanted, the interviews met no problems. Also, interestingly, some of them commented that it was a good professional activity to engage in an exploration of what they thought and felt and that it should be indulged in more often.

In endeavouring to create a situation in which a flow of respondent-initiated commentary could take place, the stance I took in acquiring the best outcome was important. It was necessary to bear in mind contributing factors within the interviews such as my already existent views and opinions (Cohen *et al*, 2011). These were being added to and adjusted as each interview progressed, so responses and questions in the later ones may have been different from those undertaken first. This might have meant that there were inadvertent steers to the respondent or interpretation of their replies to confirm my preconceived notions and possibly shifting stance. Rapley (2001) noted that he had found little research into respondents' talk, only into what was made of what they said. The point he was making was to underline the importance of how both interviewer and respondent produce the talk locally through the implicit collaboration of an interview. Therefore, when considering the outcomes of the interviews, it was necessary to bear in mind all that I brought to the process and how that contributed to the data generated from the respondent when undertaking analysis and determining outcomes. I was required and allowed to be integral to the interview process (Massarik, 1981; Rapley, 2001). The apparent limitations of interviews arising from human

fallibility, discussed above, may be considered an asset in educational enquiry in which the social interactions between people is at the heart of creating understanding.

3.8 Ethics

The ethics for this research were in accordance of the guidance given by British Educational Research Association (BERA) (2011). Approval and ethics release was sought through the relevant channels and granted. Participants were given opportunities at any time in the process to ask questions and clarify understanding. The project sheet (Appendix 2), containing the protocol for data collection, noted that taking part in the study was entirely voluntary and each respondent was free to withdraw at any time without giving reason and without penalty and any existing data disposed of according to his wishes. It also stated that any information gathered during the study will be made confidential such that nobody may be identified and that in accordance with the Data Protection Act (1998), it would be stored in a secure place and disposed of appropriately. Each respondents signed an agreement and had a copy.

One key ethical issue was the honesty with which the process was undertaken, which included consideration of privacy, anonymity and confidentiality, together with avoidance of betrayal or deception (Cohen *et al*, 2011). All communication with potential respondents endeavoured to adhere to this adjunct, taking the approach of transparency and honesty in all stages of the process, so making evident my moral stance (Newby, 2010). This advice was confirmed by Kvale (1996:117) saying that “the integrity of the researcher - his or her honesty and fairness, knowledge and experience - are the decisive factors”. The participants in this study were adults who are all able to give informed consent. The data were collected in locations and at times convenient to each participant. The data collection took place over approximately 18 months with some participants being interviewed more than once over that period. At each stage of data collection, the participants saw transcripts and were invited to comment upon the accuracy. Personal data collected were separated from personal identity information as soon as possible after collection and codes used to identify individuals. Data were not stored

on portable devices and media, and once uploaded a secure network, the depersonalised data were only accessed through password security and transferred electronically, when required.

For respondents, participation in the research offered opportunity to articulate their understanding of excellent teaching. If they were to choose to pursue it further, through the application of a critical lens and the exposure of presumptions and unchallenged acceptances, it may have served to enhance their professional profile so promoting their progress as teachers and informing their interaction with colleagues, to the benefit of their school. By extension, the insights gained through valid, critical examination of theory and practice had the potential to impact on wider understanding of educationalists and policy makers.

3.9 Rigour

Pring (2000:47) considered that "reality is a social construction of the mind with as many constructions and thus realities as there are individuals [with] no immutable laws of cause and effect". This means that "research findings are created (not discovered) through the interaction between researcher and that which is researched" (*ibid*). The 'knowledge' that qualitative research produces is subject to the decisions made which are based around aspects such as ambiguity, observations, stance, layered perceptions, interpretation, individual views, bias versus standpoint and choice of focus. This concurs with the view of commentators such as Hammersley (1995), Halsey *et al* (1997) and Schwandt (2007), already considered in the literature review with respect to measuring outcomes of teaching, who expressed concerns about endeavouring to determine answers to qualitative questions by quantitative means. Van Niekerk and Savin-Blandin (2010) noted that the concept of truth and reality is established by the moral value held, maintained and reflected upon by each individual and in this context, knowledge creation is multifarious. To their minds there is a "futility of attempts to achieve 'stable', 'valid' and thus generalizable findings" which therefore "do not [...] contribute the type of understanding that is required to understand complex phenomena" (p30).

This research set out to gain an authentic understanding of the experiences and views of the participants (Schwandt, 2007). The value of these outcomes to the intended audience was determined by considering the trustworthiness of the research from four perspectives, first identified by Lincoln and Guba (1985), consolidated by Schwandt (2007:299): “credibility”, “transferability” and “dependability” and “confirmability”. Credibility was secured by taking care to ensure that the interpretations placed on the data reflected the respondents’ views. As the context of both the research and the respondents was one that would be familiar to others who might use the findings, transferability was made possible. Dependability was achieved by “ensuring that the process was logical, traceable, and documented” and, by showing through the data that the findings were not “figments of the inquirer’s imagination”, confirmability was established (*ibid*).

By examining the rigour of this research through the above process, as validity may be deemed to exist for every social situation, the concerns of Cohen *et al* (2011) were answered. They suggested that if the social researcher attempts to justify reliability and validity, they meet a paradox in that attempts to increase reliability, through exercising greater control over the process will result in an inevitable reduction of validity. Similarly, Hammersley (2008) warned of the hazard of applying simplistic view of triangulation as a validation technique, confirming Atkinson (2005:5) who stated he does not “endorse a vulgar version of triangulation through methodological pluralism and synthesis”. An intent of enhancing credibility by this means assumes that the use of different methods to investigate a certain domain of social reality is a valid means to determining the truth. This conflicts with a post-modernist perspective of multiple realities. Consequently any use of positivist terms would have been inappropriate, misleading and superfluous and hence were not used.

3.10 Conclusion

The foregoing consideration of the methodology, design and methods may be drawn together to determine the stances adopted. Thus the study sat within the qualitative, interpretative

paradigm in which the nature of the enquiry was explorative. The ontological perspective was nondualist (agent and object, producers and products are interdependent) sociocultural although the epistemological stance adhered to the relativistic social constructivism. The research design emulated a conceptual framework allowing the analysis to be thematic and hermeneutic.

Chapter 4 - Findings

These findings are my interpretation of the evidence I have collected following analysis. I have chosen to represent the data collected in this way so I can make sense, explore meaning, reason and draw conclusions about them (Silverman, 2010). This chapter presents the first of the four stages of examining the data, noted by Barmby *et al*, (2009:162): “look at the data (analysis); look between the data (comparison); look beyond the data (inference); look behind the data (beliefs and attitudes behind the data)”. Subsequent chapters address the other three aspects.

Repeated examination of the views offered by the respondents on the question of their beliefs of excellence in mathematics teaching allowed three main themes, each with several sub-themes, to emerge. The first theme was ‘confidence’, the second ‘knowledge’ and the third was that the teacher and consequently the child goes beyond, does and achieves more than what is ‘good enough’ or what is needed to meet the targets. To encapsulate this, ‘supererogation’ was the descriptor chosen. The findings are presented below with citations and quotations that have been chosen to evidence what the respondents said and to illuminate and contextualise the individual comments in wider theory. However, the views expressed by the respondents may not necessarily be identified discretely within each theme, indicating embedded interconnectedness between them.

4.1 Introducing the participants

The findings were examined from the perspectives of each respondent and each of the four groups of participants: the mature part-time PGCE students (**ST**); the teachers embarking on or having graduated from the mathematics specialist course (**MT1 & 4**) and the HEI senior lecturers (**MTT**).

The following vignettes introduce the participants, providing an insight into their experiences of mathematics from primary school to their current position. All but the students teachers had management roles with responsibility for mathematics education, with MT41 and MT42 having just taken up that role at the start of the data collection. Although superficially they may have seemed to have followed similar paths, they will have had different experiences and gained different stances on the research question. All commented on their enthusiasm for and positivity towards mathematics and mathematics education. This was tempered by some periods of poor experience in their own education.

ST1: A successful, non-UK schooling, including passing the mathematics certificate, led to a teaching qualification, specialising in English and religious education, to which she then added a further diploma in computer assisted education. She taught in a primary school in her home country. Upon moving to the United Kingdom, she took a child-minding qualification, followed by upgrading her overseas teaching qualification to honours degree level, in order to obtain a place on a PGCE course to gain Qualified Teacher Status (QTS). She taught unqualified in England in one maintained and two private schools (one as a teaching assistant).

ST2: Her experiences of mathematics when attending school were of failure, and as her life and work had not required mathematics it was not until she was preparing to take a degree in Law and Spanish as a mature student that she pursued and acquired an adult numeracy qualification. As well as working as a community development officer she had been involved with schools through her own children, volunteering at afterschool club, in the classroom and as a governor. This observation of children learning inspired her to become a primary teacher, for which she had to pass GCSE mathematics. Having an awakened interest in the subject, her chosen written task at interview for the PGCE was about the use of calculators and she selected mathematics for her core assignment subject.

MT41: The prominence of his music performance capability took him through to leadership roles in school and he was now in his first headship. He was always quite good at mathematics

until final year GCSE which was successful but disappointing. He entered teaching at the start of the National Numeracy Strategy (NNS) in 1999 and did the five day training course. He then shadowed the subject leader and gained experience. This was developed in his next school when he was given a special needs group because it was thought that as a young male he would be able to manage the behaviour of the predominantly male group. His success with results and the links between music and mathematics contributed to his growing interest in mathematics. He joined the MaST course because, as a head teacher, he was concerned that he needed to give a strong lead to his staff.

MT42 took mathematics as her specialism in her PGCE but only because she was unable to do science. Her teaching experiences had been in East London, Kuwait and Dubai before her current post as mathematics co-ordinator. She developed her mathematics teaching and was able to share her skills with other teachers with a desire to improve their confidence. She noted that mathematics was where the children she taught made most progress and she was assigned to teaching the oldest children. So she had two reasons for taking up the co-ordinator post; she was enjoying teaching mathematics and also wanted to help the many under-confident teachers.

MT11 identified two critical incidents in her own biography that illustrated the role of the teacher in instilling confidence in ability. The first was during her 'A' level studies when she had two contrasting teachers, one of whom was willing to assist when asked but then was not helpful but intimidating. The other teacher took time and went through everything which made all the difference. It was then that MT11 realised it was possible for the teacher to help or hinder. As a result of the positive experience outweighing the negative, she then went on to study mathematics and education at university. She also benefited from the teaching she received then as the second critical incident shows; one lecture finally provided understanding for something she had previously learned and used procedurally.

MT12 similarly commented on the impact of her teachers and distinguished between pleasure and success. Despite very much enjoying mathematics, she did not go on to pursue it beyond GCSE as a direct result of a teacher she did not particularly like. The consequence was reduced engagement with the subject resulting in poor results, thus success became the determinant for continued study. Even when she did have a teacher who was good she had lost the momentum to gain the grades to study it further for which she expressed regret. On entering teaching she rekindled her love of mathematics, taking a lead in school and undertaking various specialist courses before taking the opportunity to apply for and gain her mathematics manager post.

MT13's school experience was of functional routine mathematics, working independently through text books exercises rather than being taught. He had no intention of pursuing mathematics after 16, considering that he had both reached his best and had no joy for the subject. He recognised that experience of more engaging teaching would have supported an impetus for further study. On his PGCE, again he had a neutral feeling, neither like or dislike, about mathematics, being able to do sufficient to pass the course. His first management role was for science but then he took the mathematics management role when it came vacant. He was confident with leading, using transferable skills but much less so with the subject. He benefited from support from the county mathematics team and finally felt that he was able to reflect on the subject and teaching thereof.

MTT1 came from a family with a mathematics background with a numerate brother and her father making a career change to teaching mathematics. Her affinity with mathematics was not evident at primary school, where she required additional help. At secondary school she had a very exacting teacher who was absolutely convinced that everyone could get an A grade. That approach may have boosted confidence but she does not remember him or any other teacher being particularly influential in stirring her love of mathematics. After O levels, before sixth form, she started A level mathematics and it became clear she should pursue the subject.

At university she studied a 50:50 Bachelor of Education (BEd) with mathematics as her specialist subject and in her second year of teaching she became mathematics coordinator. For her third teaching post she decided to go to a middle school so she could focus on mathematics teaching. When the National Numeracy Strategy (NNS) was introduced she became a numeracy consultant working within secondary and primary. From that she joined an HEI and became primary mathematics education leader.

MTT2: Her mother was a secondary mathematics teacher and a love of mathematics had always been part of her life with these being the lessons that she most enjoyed at school. This was in part because they made sense to her, seeming very logical and part because she found them quite easy. She also recognised this lack of challenge as a possible failing of the teaching, although she liked being good at the subject. She was tempted by secondary teaching as this age group attracted her but she was also interested in PE and primary teaching offered breadth of teaching, so she did a 50:50 education and mathematics degree. During her teaching career she had been a mathematics manager, a leading mathematics teacher and then a consultant. She then combined being an independent consultant and part-time senior lecturer in mathematics education. She had not dismissed the possibility of returning to school as she had become a deputy head teacher although she was enjoying the research and academics of the university. She found she was thinking deeply about the subject all the time and commented that sometimes, she unexpectedly changed her thinking after doing something for years in one way. She found this experience rewarding.

MTT3 found her primary mathematics was accessible and enjoyable as it was pictorial and very conceptual. But at secondary school she had nothing on which to base understanding so her school experience in mathematics was repeatedly unsuccessful. She was trying and failing to remember the prescribed steps and the added negative teacher attitude compounded the problem. She went to night school where she was taught mathematics by a tractor designer and suddenly it became obvious, making sense. She took a degree in English but found the

professional mathematics in her PGCE was very good, examining structures and concepts. As a result she became much more confident. She remembers realising why she did not succeed with secondary school mathematics; it was not that she was not mathematical but that the teaching approach did not suit her. That was significant, making her believe most of the population can be numerate but they leave school thinking they are not. In her first teaching post there was no career progression in English so she took on information and communication technology (ICT) but also learned much from the mathematics specialist, finding it an exciting challenge. In her next school again there was no English post and she was given mathematics. Having decided she wanted to excel at teaching mathematics and being a determined person, she was able to improve results. However, having been told there was no promotion available at that school she became a consultant, then was made redundant, coinciding with starting as a university mathematics educator.

4.2 Themes

The three central themes that arose from the data were confidence, knowledge and supererogation. *Fig 12* shows these three main themes, the sub-themes and whether in the data they applied to the child, to the teacher or to both.

	Confidence	Knowledge	Supererogation
Teacher and child	Confidence	Of the subject <ul style="list-style-type: none"> concepts and connections 	Success, motivation & pleasure
Teacher	Pragmatism <ul style="list-style-type: none"> accountability two masters 	Of pedagogy Of the child Developing as a professional <ul style="list-style-type: none"> learning and obstacles 	Good enough The intangible Identity/personal beliefs Inspire & aspire
Child	Independence		Long-term outcomes

Fig 12: Key themes with sub-themes showing relevance to teacher and/or child

All three may be applied to both the excellent teacher and to the outcomes to be evidenced in the child who is the product of excellent teaching.

4.2.1 Theme 1: Confidence

All respondents proposed that confidence is an integral ingredient of being an excellent teacher and is also manifest in the product of excellent teaching. This included ownership, empowerment and agency for both teacher and child to which all directly or indirectly alluded.

Sub-themes are: teacher and child confidence; independence; pragmatism.

4.2.1.1 Teacher and child confidence

The respondents all believed that confidence is fundamental for an excellent mathematics teacher and one respondent noted this point several times. The teacher should be 'really comfortable and at ease with [mathematics]' (**ST2 interview 3**):

'I think if a teacher isn't so good at teaching maths it's generally down to the fact that they don't feel confident themselves' (MT42 interview 1).

This confidence is necessary for effective teaching:

'To use teaching strategies that provide opportunities for children to gain conceptual understanding through experience [...] to pick up concepts' (MT12).

Confidence in subject knowledge allows teachers to be creative and take risks, noted by two MaST graduates (**MT13** stated this four times):

'To have that flexibility in the way they teach in their classrooms [...] to allow [learning risks] to happen' (MT12).

Hence confidence combines with flexibility and knowledge of the subject to enable the excellent teacher to use assessment for learning (AfL) to adjust their teaching:

'To know that what is on a piece of paper isn't necessarily what my children need.

[They have] confidence to be able to say, in order to get the end result I need to go and fill in the gaps [...] missing along the way' (MTT2).

The teacher needs to be able to listen to the children, hear and know if what they are saying is valid or not and to act appropriately:

'An important part of this is listening to the child and having the confidence to think ... ok that's fine' (MT12).

The teacher needs confidence to admit if she does not know the answer and to make mistakes in front of the children. She has confidence in dealing with the unknown and knows these are opportunities for learning:

'Even more it means that if the teacher does not understand it they have the confidence to work with the children to clarify [...] help them and move them on' (MT11).

'It's a good thing in a way because you're only going to learn from it. [You can] relay the confidence to the children' (MT42 interview 2).

'She will celebrate it, "that's amazing". It allows you to say "truly I don't know but we'll all think about that"' (MTT3).

One student teacher, reinforced by an HEI lecturer, observed that even a starter teacher can endeavour to become more confident:

'It's recognising frailties or fallibilities or that there might be something that is a shortage is the first thing. And being willing to deal with it' (ST2 interview 2).

'The more you do things you get better at it and realise it's not so scary' (MTT3).

Confidence is necessary for teacher and child to succeed and excellent teaching can create confidence:

'In maths particularly, [the children] need to be confidence to achieve their goals. [...]

If all teachers were excellent then the children would be really confident' (MT41).

The children who are the product of excellent teaching gain confidence through teacher actions:

'[The teacher] must instil confidence in the children [because] as soon as you give them that confidence they make really good progress' (MT42 interview 1).

MT42 also noted that parents, especially mothers of girls, may contribute to children's negative confidence saying 'I was never good at maths either'.

4.2.1.2 Independence

To complement the above, several views were expressed indicating that independence is an important feature in the resultant child:

'[Independence] obviously plays a massive part in children gaining a really true maths understanding. [...] It's connections isn't it? So excellent teaching is being a little more creative about how you allow the children to join the dots themselves' (MT12).

This independence is supported by resilience and persistence in the application of what they know to what they are seeking to know. The children need to be able to 'figure it out for themselves' (**MT12**), 'have a go' (**MT14**) and 'take a learning risk' (**MT13**). This was a focus for **MT41** and **MTT3** in particular:

'Learning isn't just about a child can multiply [but that] they were resilient or they went back and found some mistakes and then corrected their mistakes. [They should] be

learning something new or applying something new in maths and saying "I can do, I can go, I like to do"' (MT41).

'What comes up massively is fostering mathematical independence, making choices about where they start, the methods they use, reflecting [...] questioning to probe understanding. [Also] lots of work on recall of facts [...] because I know it's really useful [...] but I'm much more interested to liberate them' (MTT3).

For the child to achieve independence the teacher needs to promote it:

'Get the children to start finding those links as well. Children need to ask questions of themselves such as "where am I going next?", "how do I know?" and "what do I already know that is going to help me?" (MT13).

'[There should be] less teaching and more children investigation, children being practical, starting children off [...] children to run and do stuff. Children don't need to be taught as much as they are being taught' (MT41).

'More than solving, they're creating problems and being able to solve their own problem' (MT14).

Another strategy for independence noted by MT42 is for the children to explain to each other, contributing to formative assessment. This takes time and effort but it is important because both teacher and pupil then engage in immediate feedback:

'By getting together and explaining [...] responding straight away [...] because the children know what they need to do, so they're taking a bit more ownership over it' (MT42 interview 2).

4.2.1.3 Pragmatism

The respondents recognised that teacher independence is curbed by the expectations and requirements of their profession. However, they realised that taking a pragmatic approach reduces the potential constraints. This is reflected particularly through attitude to accountability and the perceived need to serve two masters, as considered below.

Accountability and targets: All who commented agreed that meeting targets was part of the teacher's role:

'I think part of the deal is you need good statistics at the end of the year' (MT13).

Even with little recording by the children in their exercise books, one teacher believed it is possible to remain accountable:

'We've got the evidence that they can do things, we can highlight it, we can date it. [...] we don't have to then prove it to anyone because that's our professional judgment' (MT42).

There was more than one nationally set target to be met. One indication that progress had been made was against National Curriculum levels with targets:

'If the children are making the expected progress or more [...] two steps progress' (MT42)

'Getting results [measured] mostly through pupil attainment and progress' (ST1 interview 1).

These targets are subject to change and the head teacher indicated that this may have consequences:

'[The previous targets] are no longer good progress so we are pushing them further [even though] the middle school I feed to hates the fact that we send up any children with Level 3 [as it] messes with their value added' (MT41).

Another measure of the judgement of excellence cited by one teacher was the Ofsted criteria:

'To attain an Ofsted outstanding which is the general judgement, [to] be excellent maths teachers, judged on Ofsted criteria' (MT13).

Serving two masters: Some of the comments, particularly from the HEI lecturers, alluded to the need for the excellent teacher to meet the demand of two masters: that of their own beliefs of the outcomes of excellent teaching and that of the required assessments. The excellent teacher can 'tick the boxes but there's an added element' (ST2):

'Those children as a result will meet those measures of accountability [and] an excellent teacher will be able to meet those targets in an interesting way' (MTT1).

'What you want to create is a purposeful enjoyable learning environment that ticks all of those boxes' (MTT2).

The adherence to routine lessons does not necessarily mean a lack of success. Children who are taught how to do mathematics can be successful:

'They just have to churn it out [and] be good at copying and performing. [...] It can work, it's not that children aren't learning from doing that' (MT12).

'Learning procedurally can be quick and get results and can pass SATs papers' (MTT2)

Sometimes the requirements subsume the teacher beliefs, causing frustration:

'Teachers feel increasing pressure to bow down [...] whether we necessarily feel that it's meeting the children's learning needs or not. This can be at odds when you feel pressures from outside' (MTT2).

'All [the closed task] does is tick boxes. I think in terms of accountability it's actually worse' (MTT3).

MTT3 cited an example of lack of pupil understanding. She was demonstrating open questioning to a teacher but the children could not answer:

'The teacher said that if I had just asked the question in a straight forward way it would be all fine. In her lesson, she knew where they were at the beginning and where they were at the end [...] they could carry on answering those division questions' (MTT3).

Several respondents commented on the need to temper how and what they teach to meet the required targets:

'Part of the deal is that you need good statistics at the end of the year [as it is] 'the thing we are most strongly judged on [although it is] not the be all and end all' (MT13).

'My philosophy is more about the child than the result the child is getting and what I have to do is balance the fact that I also have a requirement to make sure that I get the result' (MT41).

'I still have to teach, we've still got to do SATS at the end of it, I can't scrap all that type of thing totally and do an entirely creative rich [lesson]. I can't because my hands are tied slightly [...] I still can't do it entirely differently to everybody else, because I've still got tests at the end, unfortunately' (MT12).

However, one was secure that he was meeting the needs of the two masters:

'Actually we have been able to prove that opening up the maths like we have done has had an effect on standards, and actually standards are rising' (MT13).

4.2.2 Theme 2: Knowledge

The responses within this theme are presented in the sub-themes: knowledge of the subject; of pedagogy; of the child; developing as a professional.

4.2.2.1 Knowledge of the subject

There was agreement on the need for teachers and the children to possess knowledge but seeming disagreement on the nature of subject knowledge. There was also an apparent lack of agreement on the need for excellent subject knowledge, which might be attributed to the differences in definition that arose. The respondents agreed that knowledge of the subject was central to excellent mathematics teaching but, by that, they meant knowledge of how the subject works rather than knowledge of doing mathematics. The three HEI lecturers each offered their interpretation of subject knowledge:

'Having skilled subject knowledge [...] of the big ideas of mathematics at a primary level [...] and being able to unpick the stages. [Having] the knowledge or the skills or the understanding to determine what the child is lacking' (MTT2).

'[She] has to have expert subject knowledge so when the children say something you can hear it, you're alert to misconceptions and you deal with those appropriately' (MTT3).

'[It] does not necessarily mean the teacher is excellent at maths themselves but they enact those things that are about being a mathematician' (MTT1).

However, **MTT1** added that this is only part of engaging the children.

Other respondents also commented in a similar vein:

'Their subject knowledge would perhaps be excellent, and maybe there's just that extra element' (ST2 interview 3).

'The teacher sees the purpose of maths in a real life context' (MT12).

One provided an experiential rationale for her views whereby having an excellent personal level of mathematics does not mean the same as understanding of the subject and may militate against being able to translate what they know into effective pedagogy:

'I have worked with very, very capable mathematicians who day-to-day grapple with teaching primary level children because they can't unpick the maths. It is so intuitive [...] they haven't got the pedagogy, fundamentals, they can't communicate them. They might assume [some things] are so trivial because it is so obvious to the, [like] the twoness of two' (MTT2).

'I have worked with teachers who've got a satisfactory level of subject knowledge who have become outstanding teachers' (MTT2).

There is a need for teachers to understand the nature of mathematics:

'Maths isn't compartmentalised into lots of tiny boxes which don't seem to have any purpose and lines to one another' (MTT2).

'Interconnectivity. They understand how the different parts of maths stick together; [know] where kids were missing important pieces of knowledge (MT13).

Developing this idea, excellent subject knowledge enables the teacher to teach better:

'[They] avoid keep repeating and building on things that aren't there. [They can] work out that crucial bit where it starts to go wrong [rather than] treating symptoms not cause' (MT12).

Therefore subject knowledge is central, leading to knowledge of pedagogy:

'A huge bit of it, because you have to know what you are doing and why you're doing it. You can go through every step ... why this works or why actually when you put it round that way it doesn't work' (MT12).

Pupil subject knowledge: The respondents suggested that the child who is the product of excellent teaching is able to understand and make connections through application of concepts and strategies within and across mathematics, to enable them to be effective mathematicians. For example, one of the HEI lecturers said that children should learn 'reasoning, justifying [and] hypothesising' (MTT2). Another noted the evidence of excellent mathematics teaching comes from the children:

'What the children are doing [...] and are saying and the connections [they] are able to make' (MTT1).

This was illustrated by an observation made by a student teacher who watched a lesson on division through multiplication:

'To me[it] looked like he did this amazing division sum but that process he went through to get there was still some good maths' (ST1 interview 2).

This example, which surprised the inexperienced student teacher, encapsulated number sense:

'To have an understanding of how number works [...] can use numbers in a range of ways [and] how we add and subtract and that relates to money [...] that's probably the most important at their age' (MT41).

Without this number sense, the child cannot be independent:

'You don't actually know why you do it, or if you go wrong you don't know why or where [...] you can't actually pick it up again' (MT12).

4.2.2.2 Knowledge of pedagogy

Beliefs on pedagogical subject knowledge included sub-themes of: mathematics specific pedagogy; adaptable and flexible; classroom ethos; teaching strategies; resources, each considered below.

Mathematics specific pedagogy: The respondents had different views about whether or not there is pedagogy specific to mathematics, including two of the HEI lecturers. One thought there is generic excellent pedagogy to do with teacher values, beliefs, experience and perceptions about learning combined with curiosity about and developing children's knowledge:

'[For example] there's a way of looking at poetry [...] the same as looking at a problem, so what's this piece of information telling me and what's interesting in it and I wonder what that means' (MTT3).

In particular, this means using questions but these need to be underpinned by knowledge:

'What do I want the children to learn?', 'how can that best be achieved?', 'what will I do to help that happen?', 'why will I do it that way?', 'how will I know what the children already know?', 'what do I need to think about?', how will I measure effectiveness?, 'what will I do next time?' (MTT3).

'[You can] learn questioning [...] but if you don't know what you're listening for then they have limited impact' (MTT3).

Hence another view is that for excellence, knowledge of the subject is embedded:

'An understanding of how children learn [...] specifically with regards to maths, whether it's about the pedagogy [or] making the links between aspects of mathematics very explicit. (MTT2)

MTT2 presented a useful example:

'For example, fraction and division links which is sometimes a secret that some teachers don't communicate to children. If the children haven't got that, understanding is not necessarily there' (MTT2).

The MaST graduates **MT12** and **MT13** both believed that there is a mathematics specific pedagogy. **MT12** felt that in mathematics, gaps in understanding can be masked but a child can still get by. This makes it difficult for the teacher to know that there is a problem and where it lies, necessary to real progress:

'It takes an excellent mathematics teacher to know where the problem is [and] avoid repeat teaching [...] when that is not the issue' (MT12).

'[To know] that actually part of what we need to do was to go back' (MT13).

Pedagogical understanding will also allow the teacher to teach less structured, creative lessons to engage pupils in wider perspectives of mathematics:

'An excellent teacher will be able to have a more open lesson [which might be] really circuitous' (MT13).

'Open out maths as something beyond learning a few fractions and a few procedures' (MT13).

Adaptable and flexible: The respondents' comments indicated consensus that the excellent mathematics teacher has to be adaptable and flexible in their teaching, drawing on knowledge of the subject. One teacher in particular reflected upon this:

'Move with the children, forwards, backwards and sideways. You teach in a different way, and are able to adapt to and not to stick with your one idea. (MT11).

She acknowledged that she would not have a whole week of child directed learning but would have some flexibility:

'If they find some pattern and they want to investigate it the next day, then on that short term basis ... so it probably doesn't affect, at the end of a week, I'll still have achieved what I hoped to achieve, but just not maybe in the pathway that I thought I would' (MT11).

The need for flexibility might also be when adjustment is necessary:

'If they don't understand something [or] when the lesson is going downhill [or even] knowing when to stop if it's not going to plan [which is] quite hard to do. It might go off at a tangent, but there's still some direction you can bring it back' (MT11).

This approach is possible and desirable:

'[It's] kind of going round the houses, and it might take twice as long, but the children gain the understanding because they are ready for it, and because they want to know how to do something rather than me telling them' (MT11).

Within the approach noted above, this flexibility draws implicitly on the use of effective formative assessment for both immediate adaptation or to inform planning:

'To adapt teaching within the lesson but also the next day, then next week, the next half term' (MTT2).

'You can't do a recipe. You can be thrown one day by something that would have been fine in another group. It's really tricky. [The lesson] might change according to what children come up with then you need to be willing to change your thinking' (ST1 interview 2).

The classroom ethos: To achieve success through flexible and adaptable approaches that promote independence, the excellent teacher needs to create the best possible learning environment. This was alluded to by respondents from all four groups and is to do with 'the atmosphere and being in the classroom' (**ST2 interview 2**). It is a 'positive, productive learning environment' with 'high expectations for all pupils' (**MTT2**):

'What to do when you're stuck [...] when you hit that brick wall and whether it's ok to talk to your partner, or to get out of your chair and grab a resource, or to go and flip back through your book and look at something that you've already done' (MTT2).

MTT2 noted that children may regard these as cheating so the teacher must be explicit that they are valid self-help strategies that people will use in real life to help them be successful.

Within this environment the excellent teacher will actively promote an ethos of joint shared purpose in which struggle is reasonable and children should 'have no fear of saying "I'm stuck"'. We're all a learning community together' (**MTT2**):

'First create that kind of environment where you bring them on board so they would want to do it with you [...] to being able to talk to you and being at ease with you, and say to you what they are thinking, so they are not scared of learning' (ST1 interview 2).

One student suggested a teacher strategy of flattering the child:

'Your brain is working much more efficiently than mine at the moment, well done; let's look at what you've done so far' (ST1 interview 2).

However the excellent teacher does more than manage. Through their confidence and knowledge, they use teaching strategies that extend children's independence:

'So they push or challenge themselves [within an] environment where it's ok to admit you don't understand' (MT11).

Several of these points may be combined by stating that the teacher needs to take a flexible approach to meet the needs of the children:

'Take the children on or move them back [even when there are] six different things needing to go on' (MT11).

Teaching strategies: The respondents presented their views on excellent teaching strategies to promote learning within this environment. This is a theme that **MT42** had much to talk about.

One aspect is to motivate the children through making the mathematics accessible:

'[Start with] something they find quite easy [then] they start to like it; something that will get them on board, grab their attention and get the children to talk about the maths. When they feel "yes, I can do this" the teacher can then give them something a bit more challenging [...] and really invariably they achieve it because they've got that confidence to do it and they want to have a go at it and they want to get better at it' (MT42 interview 1).

'Probably to give problems that are within their grasp, [...] and then to just be there with them asking [open] questions that might lead them to find the first step' (ST1 interview 2).

One HEI lecturer chose accessibility when she tried 'to pinpoint one thing' that makes an excellent primary mathematics teacher:

'Making children engaged and wanting to learn [which needs] a sound understanding of how children learn but being able to present it in a way that hooks children in [...] pitched at the right level [...], builds on prior learning' (MTT2).

The respondents noted the need always to challenge the children appropriately and this in turn challenges the teacher:

'The challenge is to recognise how to move each child on just a bit [...] knowing how to be with different ages' (ST2 interview 3).

Some indicators of an excellent lesson, although not easy, are investigation and problem solving:

'Logical thinking [and] life skills. [To know it is] okay just to have a lesson for the journey of that lesson rather than for the end result of that lesson, to leave it open [...] especially maths' (MT42 interview 1).

'There should] always be little bits of problem solving in every lesson [with] a big major task each week' (MT42 interview 2).

This includes both preparations when planning and responsiveness when teaching:

'How else can we do that, what other way can we approach that? I'm just trying to think of different ways to do things and then another way of consolidating' (MT42 interview 2).

She recognised that children are 'not going to just sit and work'; the teacher has to capture the children's attention and so will need to 'think outside the box a bit' (MT42 interview 2).

MT42, appointed for her mathematics expertise, changed her practice during the year on the MaST course:

'Previously I taught my pupils how to do something and then they did it successfully [but] my practice has changed' (MT42 interview 2)

She then listed a range of her revised teaching approaches to ensure the children were being active learners, rather than passive:

'Lots of different ways of giving them confidence [...] a lot of practical work going on and the emphasis is on "doing". Experiences and using the concrete materials, giving them visual things, kinaesthetic things, lots of different ways, [...] the experience that will stick in their mind and help them to retain what they're learning' (MT42 interview 2).

However, problem solving as a strategy does not necessarily mean excellent teaching:

'So we focus on problem solving but I don't think we really get a problem solved, I don't think it [...] embeds' (MT41).

This head teacher was also concerned about lack of cross-curricular mathematics:

'Teachers don't link maths into the curriculum in the way they link English' (MT41).

MT42 also had become aware of the detrimental effect of requiring the children always to record their work:

'Often they'll come back to me and say ... I'm just not confident to do it in my book, yet they can do it on the white board, but because it's so permanent in their book, they just don't want to do it. [...] That's there forever [and] if they're just really scared of doing that, they're not going to show us anything, they're not going to commit to it' (MT42 interview 2).

This meant formal recording would not necessarily happen. It would occur, however, when the children grow in confidence and are ready:

'Rather than worrying about them writing it down all the time, when they show me that they're ready to do that in their books, and next time we revisit that as a topic as such, and go onto it, we can then make more of a commitment' (MT42 interview 2).

Additionally, pupils and teachers need to accept that there are times for more mundane mathematics:

'So there is some mathematics that is routine, there is a need for instant recall, and possibly sometimes there is a need for a closed task, and there is a need for exam technique as well' (MTT1).

However, this has limited cognitive value if isolated from practice and not reinforced through application. Children must not see that as the entirety of mathematics:

'When I was back at school they did this, you did it on the board, you understood it, you did it in your book, but three weeks later you might not understand it, you can churn it out when it's required' (MT12).

Resources: Resources (other than the teachers themselves) were barely mentioned as a discrete consideration. As noted above, within teaching approaches the children should be engaged with multisensory activities. However, one lecturer provided a cautionary note about inappropriate or unnecessary resources:

'If given the wrong or unnecessary resource [this is a] barrier to learning [...] and a distraction' (MTT2).

Only one respondent mentioned commercially produced mathematics schemes:

'In the main [a good maths scheme] will probably be better than anything you can produce. [Ours is] really passionate [and] has a really clear understanding of how maths should be taught' (MT41).

However, the same teacher expressed concerns about schemes:

'I think there's an over dependency on maths schemes [...] perhaps when subject knowledge is not great' (MT41).

4.2.2.3 Knowledge of the child

Much of the respondents' additional observations that might be related to knowledge of the child were embedded in their thoughts associated with pedagogical subject knowledge, but there were some other comments. The sub-themes are: individual needs; individual capabilities; affective responses.

Individual needs: All respondents reflected that the excellent teacher succeeds because of their knowledge of the needs of individual children. Excellent teaching puts children 'at the centre [and] it's doing as much for the children as we can' (MT42 interview 1). There is a need for 'very in-depth awareness [of] exactly what their issues are and exactly what it is they can't do' (MT12).

Part of this is the quality of planning but this is not formulaic. The excellent teacher will interpret planning documents as they deem appropriate, noting the progress of each child and adapting:

'They're rewriting them for themselves, so actually what's nice is when you collect planning after it's finished, how many people will scribble on meaningful notes' (MT13).

'[Excellent teachers] are much better at making those links and creating activities for the children which are rich and have meaning' (MT13).

'Look for those learning values [showing] the massive, varied experience of being a child' (MT41).

Individual capabilities: Some respondents remarked that the different needs of children sometimes arise from different capabilities, especially noting the outer boundaries of the class ability range. Excellence is knowing that different things work for different people, what makes each child work and not expecting everyone in the class to operate in the same way:

'Each child should be encouraged to be better and reach higher. [...] Everybody has a unique strength' (ST1 interview 2).

The excellent teacher knows the needs of the more able children in the class:

'[Able children] often get stagnant. Giving them something easy will just switch them off whereas giving them something challenging to get their juices flowing [...] will set them off' (MT42 interview 2).

One student teacher thought that excellent subject knowledge is an aid to meeting the needs of these children:

'[It] is an additional bonus for some children who are particularly gifted, they have the ability to take those ones on further' (ST2 interview 3).

Correspondingly, one teacher considered the needs of the children who make the slowest progress. He was concerned about them becoming over-reliant on support:

'An [SEN] child must have an adult with them [so that] independence is not fostered in these children either' (MT41).

Another view of the needs of these children was given by one student teacher, reflecting the need for knowledge of the subject to inform pedagogy:

'I think with the struggling ones, it's more how to teach than what to teach ... yes and breaking down whatever it is that you're trying to teach into bite size portions that can bring them on (ST2 interview 3).

However, she thought that this meant you did not have to be an excellent teacher.

An organisational device that is available to schools is re-arranging the classes into sets that have narrower ranges of abilities:

'Setting in maths is brilliant. [Mixed ability teaching] can really disillusion the lower ability children [and] the higher ability children can get bored. [...] It's a lot harder to have excellent lessons as often as you would if you had a set' (MT42 interview 2).

Affective responses: There was little in the interviews that was specifically about the affective factor with much embedded within the consideration of pleasure and pride, presented earlier. However one student teacher commented that 'happy children, who feel safe and cared for, achieve to the best of their abilities' (ST1, interview 1). She also thought 'it's important not to push [...] too quickly' (ST1 interview 2). She cited an example of a child's response when a teacher gave each child a question to answer before they could go out to play:

'He thought that was awful, he thought that was terrifying, just the idea terrified him, which I found really interesting because he's always been fine with maths' (ST1 interview 2).

In this incidence, the child's situation was exacerbated by the incidence being at the start of a new academic year and hence a new teacher. ST1 concluded that some children appreciate being challenged and pushed but this will have an adverse impact on others.

4.2.2.4 Developing as a professional

A teacher's education does not stop when qualified. Development, both formal and informal, is part of professional expectations. Sub-themes in this section are: learning and obstacles; learning excellence; reasons for lack of development.

Learning and obstacles: There was not agreement in the responses to whether all teachers could become excellent mathematics teachers. Excellence is not possessed by all and may not be possible. For example, one HEI lecturer reflected that she did not think she could become an excellent art teacher. It also may not be necessary:

'Not everyone can be an excellent maths teacher. We have a responsibility to send out 100% of students who are good enough maths teachers with the hope that we also send out a percentage who are better than that, who can then continue to influence [others]' (MTT1).

However another HEI lecturer and one of the teachers held that all teachers have the potential to become excellent if they are open and receptive to reflecting on their practice and listen to support and guidance:

'I have people who started on a PGCE course last year for example with ... "I hated maths, I don't see the point of maths" ... attitude ... and actually, by the end of the year I've seen them deliver outstanding maths lessons because they're change in thinking has shifted so significantly in a year' (MTT2).

'In theory, yes. I don't think it's like a magic thing you have. [...] The most important thing is that you're constantly trying to improve [...] there's no harm in trying, as it's possible' (MT42 interview 2).

However, she and others believed that it is probably not possible or realistic to be excellent all the time, although this does not necessarily mean you are not an excellent teacher:

'No. I don't think anyone could say that they are excellent all the time [...] no matter how well trained you are, how much experience you've got. Even though you're not excellent all the time you could have an overall air of excellence. We all have rubbish lessons at times but that doesn't mean you are not an excellent teacher' (MT42 interview 2).

'I'm not sure we have any teachers who are excellent all the time in their maths teaching. [...] I think it's almost impossible to do that all day every day without it finishing you off' (MT13).

'Probably depends on lots of things [...] and an excellent teacher will have more excellent lessons [...] than just a good one. [...] I can't believe that a teacher could be on top of their form and be excellent in every single lesson, every day of the week [...], it's not sustainable' (ST2 interview 3).

This student teacher questioned the need for excellent teaching:

'Probably isn't necessary either. Children still achieve and do well [and] there aren't that many excellent teachers' (ST2 interview 3).

Learning excellence: The role of management received brief mention as a discrete point. A student teacher indicated that excellence is not always valued:

'She was doing something in the school and being quite good but the school wasn't necessarily favouring that excellence. I suppose it's possible to be a good or excellent teacher even, in an environment that's not necessarily favouring it' (ST2 interview 1).

One of the difficulties **MT41** faced in achieving this excellence is that there had been turbulence in leadership with four head teachers in as many years. The respondents reflected that 'some elements [of excellent teaching] can be learned' (**ST2 interview 1**) and two believed this requires a collegiate approach with the impetus coming from management who have the will to promote excellence:

'It's about getting the continuity through the school as well, and making sure that it's streamlined, and everyone has got a similar approach [...] looking at continuity and planning and consistency [...] so really making teachers aware of what the goalposts are and what we expect to see in an excellent lesson' (MT42 interview 1).

'I think the next thing is to create time for teachers to develop excellence [...] to reflect [...] to do [...] to engage in CPD [...] to collaborate (MTT1).

However **MTT1** acknowledged that there is no point in spending time if it has no impact on teaching and hence on children's progress. Most teachers are 'very good and very conscientious and want to do their best' (**MT42 interview 1**). Therefore, to make the best use of continuing professional development (CPD), the approaches made by those teachers arranging staff development was to include and value the contributions of all. If teachers can 'see a big picture, [have] professional freedom' (**MT41**) they gain ownership and hence are more likely to persist with changes in practice. Two teachers particularly commented on CPD approaches:

*'To give them that confidence [...] look at those problem areas, and look at the things they find difficult, and really focus in on those areas that they do struggle with' (**MT42 interview 1**).*

*'At the staff meeting, I made sure I fed back about the teachers who I knew weren't very confident, saying "I saw this really good thing in this lesson" just to remind them they were on the right track' (**MT11**).*

*'But I was also a little bit sneaky and before the staff meetings, I would speak to a few people who I knew were on side and say "can you bring something and show that this is working", because there were some people who weren't prepared to try as hard as others' (**MT11**).*

Getting teachers started with change means recognising the need and then putting support structures in place:

*'There were lot of teachers planning on their own, not planning in the year group, there was no discussing, and we needed to change it' (**MT11**).*

'I don't think it's easy [...] to think of the problems, find your investigations. To have a bank of those is quite helpful to teachers that they've got those to make them a regular part' (MT42 interview 1).

However, although this might upgrade the planning, this is only a starting point and there are other improvements to be made:

'Superficially we can be outstanding, as our planning identifies a flow in learning, and opportunities for children to develop etc. etc. ... but if you're not actually there asking the questions and listening to the responses ...' (MTT3).

One strategy adopted by one MaST was to target individual staff development:

'We started with making sense of all of the available resources and how the curriculum looks, and saying "don't do it like that, don't do that there", and actually making links, and then I did some lesson planning with him, and some team teaching, and there were observations, (MT13).

This proved successful:

'His maths has improved, his confidence is up ... he always had it, but it was about making critical decisions about what you need to teach, and how [...] and actually making better use of assessment for learning' (MT13).

The improved standard achieved through this staff development was an upgrade to good, with the target to become excellent. This would be when teachers and their pupils develop 'resilience and take a learning risk' (MT13). They make links between areas of learning across the curriculum and within mathematics:

'Certainly it's interesting, having observed quite a lot of lessons, looked at books, the quality of learning and teaching has improved quite significantly in the last 5 years'

(MT13).

Lack of teacher development: It may be, however, that the desired outcomes of necessary improvements are not achieved. This may be because of time pressures:

'It is difficult [to achieve] when schools and teachers have got so many other draws'

(MTT3).

It may also be because of teachers retrenching to secure ground, being reluctant or disinclined to change practices or underlying beliefs:

'It doesn't always happen. [...] Like the lady I work with who is quite happy to try out new things but always comes back to what she's safe with' (MT11).

'All have the skills [but] some of our less confident members of staff are sticking with some of the bits of the strategy that work for them' (MT13).

'Some teachers need to be shifted [...] to allow those situations to evolve' (MTT3).

One MaST graduate gave two examples of what prevents a lesson from being excellent. Lessons that could have engaged the children in making decisions about choosing a method that best suited them were co-planned. However, although both teachers she cited expressed commitment to try the ways they are given to be excellent, in the end they were unwilling to change and to let go of what made them feel secure:

'And the lady came up to me and said "I'm really pleased, I've filled in the last tick and they can all do the carrying method" and she'd done a whole day of going on and on at the method until they got it. [...] She'd been quite happy to try out my ways of approaching addition, subtraction, and keeping it quite open, looking at different

methods, sharing methods, sorting questions out into mental and written and all that kind of thing, but when it came down to it at the end, there needed to be "they can all do this" the success for her' (MT11).

'There's a lady [...] who is lovely and has been teaching for a long, long time and still, as creative as I try and help her to be, she still has to have her tick sheet at the end, being able to say "yes, they can do all these objectives", and if they can't she needs to go back and fill them all in. [...] She is quite happy to try out new things but always comes back to what she's safe with' (MT11).

Some of the respondents who had management responsibility to raise standards noted that some teachers could not cope with the insecurity resulting from lack of direct control:

'[They get] very anxious that they're expected to know something they don't know.

"But what if [the children] are saying something you don't expect?"' (MTT3).

To prevent putting herself in this unsettling situation, the less strong teacher 'will go back to a more structured lesson' (MT13).

Even staff development using a range of strategies may not succeed with recalcitrant or intransigent teachers:

'Not everybody is prepared or has the time to get the knowledge and understanding that may be necessary. [...] Nobody will change unless they see a purpose of changing' (MTT3).

MTT3 cited as an example a teacher who photocopies on a Monday all the sheets for the week. After a CPD observation, they discussed the lesson:

'So I asked "What are you going to do tomorrow, now that we know what the children know and what they don't know?" And she looked at me astonished, "Well I've planned this"' (MTT3).

Another case that she had come across when an LA advisor was of a head teacher whose monitoring regime was to observe a teacher teach the same lesson, once a year, every year:

'The teacher knows this activity well enough, that actually she's experienced enough to know all the possible cul-de-sacs and things that children write. But the children aren't gaining excellence from that, are they, if you only do it once a year?' (MTT3).

After staff development input by **MTT3**, the feedback from the head teacher indicated that the teachers had not taken ownership of the ideas:

'All they're actually doing is imitating what you did, so they've taken your ideas and the week after you come in we've seen puppets and we've seen counters and the Numicom's been out (MTT3).

As a result, despite the input from **MTT3**, once the ideas had been used, the teachers did not maintain the momentum:

'After they've used your ideas, they don't have anything else, even though, and I know because I was there, you spent the afternoon with them getting them to plan and adapting and innovating from these starting points' (MTT3).

4.2.3 Theme 3: Supererogation

Responses in this final theme relate to the beliefs that the excellent teacher goes above and beyond what is required to meet their targets and, by reflection, so will the child. Sub-themes are: success, motivation and pleasure; long-term outcomes; good enough; intangible; identity and personal beliefs.

4.2.3.1 Success, motivation and pleasure

Both teacher and pupils benefit if they take pleasure in mathematics. In addition to knowledge and confidence, the teacher's positivity contributes to pupils' learning:

'To have a love or a passion of maths has to feature somewhere quite high up on the list. To appreciate the power that it has, on a day-to-day level, [...] enthusiasm for the subject, [an] appreciation and love of mathematics' (MTT2).

Children who possess confidence and knowledge experience enjoyment, gratification and the desire to persist, creating a positive feedback loop.

'Even if they found the mathematics difficult, they'd still enjoy it and it would be something they'd look forward to and enjoy doing it.' (MT42 interview 1).

Pleasure and pride in mathematics and their achievements were suggested as characteristics of the child as a product of excellent teaching, additional to possession of skills knowledge and understanding. This is not specific to mathematics:

'They derive great pleasure from achieving their goals' (ST1, interview 1).

Respondents from the other groups (MT4, MT1, MTT) noted affective characteristics such as enjoyment, pride and happiness, related specifically to mathematics:

'Children who get much better at thinking, enjoy being able to be like that [...] find challenge to be motivating. Children feel proud of their achievements [in an] atmosphere where everything's valued' (MT11).

'So happy, they had such a lot of fun, they did lots of exciting things, they really enjoyed their time [...] mathematics is active, it's fun, the children are engaged and they are solving problems' (MT41).

'It generates in children a sense of excitement when they have found a pattern [...] or a generalisation' (MTT1).

One tangible manifestation of this is the way in which they talk about their school:

'If they are talking about the things they've enjoyed doing, the underlying nature of that implies that they are [...] learning the basic skills, they are able to go and communicate and explain [...] we're talking about positives in school' (MT41).

4.2.3.2 Long-term outcomes

An impact of all of the above indicators of excellent teaching, drawing on teacher confidence and knowledge, was deemed to be the long-term benefit, extending from the end of primary school and beyond:

'Knowing that sometimes you're playing the long game, knowing the long term benefits will come in the end' (MTT2).

At the end of primary education one teacher suggested that children need 'the very basic skills of addition, subtraction, multiplication' (MT42 interview 1). The reason for this was offered by one of the HEI lecturers who said that this was not just 'because it's statutory [but also for] future careers [as] capable competent citizens' (MTT2):

'Learning with understanding takes time [...] equipping children with a repertoire of strategies [helps develop] resilience and resourcefulness [...] and that continued determination to achieve rather than just wanting the instant gratification. Life's not like that. [They] learn that grappling with something is when you learn more' (MTT2).

Both the student teachers noted the long-term advantages of excellent teaching reflecting that the benefits may not be immediately apparent:

'To be in a place for a long time also helps because you grow in confidence as well' (ST1 interview 1).

'Excellence makes the learning stick. [It is] not just for the moment but it's something that will continue' (ST2 interview 1).

This student also commented on the long-term limitations with a less than excellent mathematics education:

'Children will tick the boxes [but] may just go through learning everything but not be curious, not be interested, not be investigating as they grow up' (ST2 interview 1).

4.2.3.3 Good enough

In addition to providing their views on what characterises an excellent teacher and teaching, the respondents also provided examples of what was considered not excellent but good enough. Sub-themes are: comparing good and excellent; knowledge of the subject; the reality of expectations.

Comparing good and excellent: Good, rather than excellent, teaching may have limited creativity or reflect lack of confidence but would achieve the targets. As these lessons did not fit with respondents' beliefs about excellent teaching they could not be excellent lessons. However, one teacher acknowledged the children would have been able to undertake the calculations successfully, to meet the aims. There 'maybe moments of excellence' (MT11).

A head teacher typified the less than excellent, but good enough, teacher who is selective about what they teach from agreed planning:

'They just do ... day 1, day 2, day 3 ... they follow it through. They miss out some of the bits they don't like, [...] you'll find stuff crossed out, because they won't have done it,

but they'll then move onto day 3. It's easy to skip bits, and then assume you're going to come back to it' (MT41).

He also identified low differentiation and overreliance on other adults to support children with special educational needs (SEN), not fostering their independence.

He considered reasons for the skipped bits, citing an example from his monitoring role as a manager:

'Sometimes it's too much to do, so it might need more preparation. The sad thing is like in Year 1, there's no maths area set out with them doing practical things and I keep having to go and say "Where's your maths area? Where's your practical area?"'
(MT41).

In these classes there is an underuse of practical maths and even when the practical resources are made available their use is not directed:

'If you sit the children on the carpet and you tell them, it's easier to control their behaviour and you can also assume [...] I know I've taught them all this' (MT41).

MT41 recognised that this is a superficial indication of children's learning:

'Actually what you don't know is what they really know so you can make quite generalised assumption without really having a good evidence base to work from'
(MT41).

Knowledge of the subject: As considered earlier, knowledge of the subject was considered important; however good subject knowledge results in good, rather than excellent, teaching:

'Good tends to be from sufficient subject knowledge' (MTT3)

'[Subject knowledge] may just be adequate but still know the children well and be able to take them on' (ST2 interview 3).

Reality of expectations: Two lecturers thought that children would not have an excellent mathematics teacher at all times but a varied experience of all subjects across their time in primary school:

'[Each teacher will] indoctrinate them really in a way of working, and into your values, [...] you make it very clear what you want and most children will strive to do that. I think in some schools it's just a case of damage limitation' (MTT3).

'I'm not sure that you need that every minute of every day ... in a child's school career 'good enough' will do for some of the time' (MTT1).

One MaST graduate explored the need to expect teachers to be excellent and the consequences of not meeting that expectation:

'I don't think [excellence] is necessarily necessary, if that makes sense' (MT13).

'I think what you're looking for is a teacher who is consistently of a high standard and is supporting their children's learning all day every day, so not just the day when OFSTED or the senior management come in (MT13).

He also considered that, for the most part, good lessons were sufficient for the required progress:

'I certainly have seen lots of good maths lessons where children make good progress, and I've seen a few that have been excellent, but with a few of those you could almost put a cigarette paper between them' (MT13).

Another MaST graduate also acknowledged that good enough was sufficient:

'I would argue I don't think they're learning in a way that I would like children to learn in my classroom as I don't necessarily think it always goes in and stays in. But that's not to say that's bad maths teaching, I think that's the difference between maybe good teaching and excellent teaching. I suppose excellent teaching is being a little bit more creative about how you allow the children to join the dots themselves' (MT12).

4.2.3.4 The elusive

There were some comments that indicated that articulating what typifies an excellent teacher is not necessarily easy:

'To someone looking in from outside [...] I don't think it's an obvious thing. I think it's an awareness that a teacher has in the classroom. If people came and looked in my maths books, I don't think they would say "this teacher here is miles apart from this one down there"' (MT12).

For one MaST graduate respondent the least articulate and fluent part of the interview was when he tried to define an excellent lesson. He commented that 'actually making a judgement on one lesson is quite difficult' (MT13) but even over a period of time, it was difficult to pin down:

'Quality of questioning', 'pushing children's learning on, 'pedagogical understanding', 'it's that whole bit about you feel something', 'you know it's excellent', 'sometimes that quite hard to unpick', you get a feeling', 'if you are going to be excellent you have to have that extra bit' (MT13).

A student teacher noted that 'it's hard to tell, to know [...] making them accountable in tangible ways is hard' (ST1).

4.2.3.5 Identity and personal beliefs

This final section draws together aspects of excellence that might be ascribed to the individual identities of the respondents, relating to both non-specific and mathematics teaching and the fundamental need to inspire and aspire.

There was agreement on some elements of generic teaching such as valuing the child, having high expectations, meeting 'every child's needs, facilitating their progress' (MT12) and on team working. The student teachers both made observations about the excellent teacher in general:

'I think there is a natural interest in the children themselves as people, rather than just "I'm here as the teacher to impart something". I think that's where the excellence comes in' (ST2 interview 1).

'Works well as part of a team and promotes this skill in others' (ST2 interview 2).

'High expectations of good and acceptable behaviour, a family environment, a mutually respectful team' (ST1 interview 2).

'Meeting the needs of individuals through task setting with support and promoting independence helps to achieve success and confidence' (ST1 interview 2).

The teacher needs the children to see them 'in a certain way [as] the professional' (ST1 interview 1). If the teacher creates this impression then the children will not question the teacher capabilities.

There was also agreement on beliefs specific to mathematics education. The respondents commented that the excellent teacher also has to be pragmatic, reconciling idealism and demands of accountability. The teacher is fallible and children benefit from knowing this as it creates mutual respect:

'There's no benefit of children thinking we're perfect, it's just not how life is, and I think it's important they know that, and you learn together. My children definitely in here, they ask me things, and some of the maths questions I don't know, but we'll find out'
(MT12).

She talks positively about the power and value of mathematics:

'Key is being able to communicate the point of maths to children so that it's not just an abstract aspect of the curriculum that we do because it's statutory, but because we feel that we're helping children for future careers, but also to be capable, competent citizens really' **(MTT2).**

'An ability to see maths everywhere and to see that mathematical opportunity. Sometimes it can be quite small and then promote an enthusiasm for that' **(MTT1).**

She models:

'There is something that is about that excellence in teaching that [...] pervades everything you do [but in mathematics] you are being that mathematician that you want children to be' **(MTT1).**

She holds a long-term view:

'To help children to learn, to develop social personal skills and become useful citizens [...] would like to make a small impression in a child's life' **(ST2 interview 3).**

'And a recognition of potential. Not just that "this is the year they've got with me and this is what we are going to do" but what will that child be in the future?' **(ST2 interview 1).**

She enthuses:

'Instil enthusiasm in the children' (MT42),

'Fosters in children a fascination for an appreciation in mathematics in its own right (MTT1).

'It isn't just about learning and formulas and methods but [...] being able to apply learning [and knowledge] to situations. [...] You have what is written but then there's the interpretation [...] be the teacher, the individual person, interpreting the situation' (ST2 interview 3).

She does her utmost to engender understanding:

'You can't make someone understand maths [...] we can't make it go in, we can't make them understand concepts, they have to be able to experience that themselves, which is why I think it only works for a little while. I think to have a really true maths understanding, they need to experience it themselves' (MT12).

The HEI lecturers agreed that children need to be inspired although one did question whether it is necessary to have excellence to achieve inspiration:

'Do we need excellence for children to be inspired ... or will they be inspired by the nature of the content itself, and the fact that maths is interesting to them, and it comes from within them, not translated from the teacher? I think that's difficult to answer' (MTT1).

Nevertheless, inspiring teaching would be desirable:

'I think you would like to hope that in a child's career, they maybe come across somebody who is inspirational in their teaching of mathematics' (MTT1).

Finally, two respondents specifically mentioned the need for the excellent teacher to be aspirational:

'I think we should aspire for excellence, but whether or not we always will achieve it is something different, but definitely I think it should be an aspiration. [...] I think excellence is the thing that we won't achieve consistently, so it will keep us want to ... I think it's impossible, but we'll always aspire towards that (ST2 interview 3).

'If you struggle with something yourself often that makes you a better teacher. [...] I struggled [pedagogically] because [mathematics] comes naturally to me. [...] It's necessary to aspire to be good [...] you need to be able to aspire to be excellent [...] if you are not even going to try then what's the point?' (MT42 interview 2).

This in turn will inspire the children to be aspirational:

'[The children] would also aspire to excellence, creating a culture' (ST2 interview 3).

One lecturer summed up the excellent teacher:

'Always learning, always questioning yourself [and] the point where you think you've learnt everything there is to know is the time to leave teaching' (MTT2).

4.3 Conclusion

The three interdependent themes of confidence, knowledge and supererogation materialised throughout the data with none emerging as dominant. Respondents from all groups expressed views relating to each of these themes and, whilst there was not necessarily agreement on specifics, there was overall consensus on the principles.

Chapter 5 - Discussion

The findings presented beliefs and perceptions about excellent teaching that interweave around the teacher and the child with some being specific to the child, some to the teacher and some germane to both. Consideration of the child gave rise to questions about the child both intrinsically as a learner as well as extrinsically as the vehicle by which success is measured. The respondents tacitly endorsed the professionalism of the teacher striving to meet these twin outcomes and the dilemmas faced by school leadership. These included endeavours to realise excellent teaching from all teachers whilst acknowledging that, to all practical purposes, achieving excellence from time to time is acceptable and 'good enough' is sufficient to meet short-term, externally generated targets. By association, the respondents gave a tantalising glimpse of the long-term potential that may be realisable if excellent teaching is enacted and experienced by all. The analysis revealed and illuminated unexpected, surprising, interesting and new perspectives. The main outcomes of the research were: three interdependent themes which contribute together to create excellent teaching in primary mathematics; two dichotomies exemplifying the complexities of teaching; and the interesting perception of 'good enough' being sufficient to meet targets. The formation of a metaphor provides a unique representation of the views and ideological stances of the respondents.

The combination of the metaphor, the three themes and two dichotomies addresses the sometimes seeming elusive unquantifiability of excellence which also emerged from the data, giving the possibility of making the characteristics of excellence explicit so reducing intangibility. By comparing and contrasting the responses from individuals and groups, matters for further consideration are identified with consideration of the principles of communities of practice as developed by Wenger (1998, 2010).

The following discussion is presented in three parts to explore these outcomes and synthesise with relevant literature. The first part presents the metaphor and contextualises the themes

presented in the findings. Part Two examines the two dichotomies: the intrinsic motivation of the child as a learner and the extrinsic incentive using the child as the measure of success; the teacher determining outcomes or if required outcomes determine teaching. Also explored are the means to becoming excellent and the difference between good and excellent with consideration of 'good enough'. Part Three examines how the research outcomes might be attributed to the stances held by the respondents.

5.1 Part 1

5.1.1 Introducing a metaphor

A device that proved useful to examine the implications and significance of the findings was to incorporate a metaphor. One analogy that seemed to represent the views and beliefs expressed by the respondents was the model construction system, Meccano®. The company states in its marketing information that it is "a very versatile constructional medium. Almost any mechanical device can be built with it, from structures, to complex working cranes, automatic gearboxes or clocks. Meccano® is frequently used to prototype new ideas and inventions. Model realisation using Meccano® is limited mainly by the imagination and ingenuity of the builder" (Meccano, 2014).

At its most basic (scenario one), it is possible to buy a set with the exact parts and instructions to build a bridge. With a little concentration, some reading and fine motor skills, the bridge can be built to a high standard, matching the illustration on the box, thus achieving a strong sense of accomplishment and satisfaction. Having completed the task, the child might either leave it on show or take it apart. The child may acquire several such sets and hence this will create variation in the construction tasks through building each one in turn. The complexity of the models may also increase moving on from just joining parts together to the use of cogs and gears, demonstrating the interconnectedness of cause and effect. The child might work with a friend, which may speed up the construction if they are able to work collaboratively or may

reduce the effectiveness of the build through disagreement or lack of cooperative skills. This scenario might be sufficient for the child who does not aspire to more through choice, lack of desire or lack of knowledge of other possibilities.

A second scenario, occurring through accident or design, is that the parts and instructions from the sets are put together in one storage box. The child will be more challenged to build the original models as he will have to find the parts but he will still have the security of the instructions. He may even be able to make modifications either to accommodate lost pieces or to explore other possibilities through active engagement. The uniformity of the parts would support the developing creativeness offered in this situation. If working with his friend, they may still not work together well and indeed, have more opportunities for disagreement with the wider range of options. However, the potential for learning from each other increases when there are variations to consider, as opposed to the procedural approach of the first scenario.

The third conceivable scenario is for the parts from several sets to be put into one box without instructions, opening up the potential to construct whatever is viable. Of course, the possibility of frustrating lack of progress is greatest in this situation but the opportunity for a heightened sense of satisfaction and boost to self-esteem is prodigious. What is built will arise from the child's imagination, drawing on any expertise already developed and may be undertaken just for the fun of it, or may surface from something of current interest. The child may have a clear, specific picture of what should be the outcome or may only have a vague sense of intent. He may decide to plan and sort parts before starting construction or may choose to just get started and see what transpires. If a plan is created, the construction may go smoothly, especially as the child gains more experience. Also possible is that the plan does not work and modifications need to be made. This might be done by re-planning or by resorting to seeing what works. It may also be that, having planned, during construction an alternative occurs and modifications are made. In this context, the uniformity of the pieces

may be a barrier to truly creative construction but will also act as security to confidence. For the child who does not plan, the evolution of the model will be organic, progressing through trial and improvement. Either way, the eventual outcome may or may not be what the child had in mind (if indeed this was ever clear). Also, he will likely have undergone a range of headways and regression, frustrations and successes. If working with another child or children, the potential noted in the second scenario for gaining from each other (or for dispute) is magnified. They may well not be able to articulate what they have learned either in term of knowledge of construction or in terms of persistence, determination, collaboration and so on, but they will be able to draw on it for the next time.

Scenarios one, two and three might be considered to equate to poor, good enough and excellent teaching and learning but I suggest it is more complex. The respondents do not deny the value of routine and practice as these form the groundwork for use later. All scenarios have import as stages towards the child described by the respondents as a product of excellent teaching. When applying this metaphor to the continuing 'chicken-and-egg' debate (see Mason, 2012), it might be inferred that a progression from scenario one through scenario two to three is the way that learning is best achieved through engaging with basic procedures first. Certainly, the child would become adept as the motors skills of construction before endeavouring to construct creatively. However it could be equally argued that if the child starts modelling with scenario three, those skills could be learned alongside experimentation, offering opportunities to integrate both procedural and strategic development concurrently.

5.1.2 Contextualisation of themes

Each respondent gave her or his particular views but there are many aspects that they all clearly articulate that define a collective view of excellence. The themes of confidence, knowledge and supererogation were derived from the views expressed by all respondents, representing student teachers, class teachers, mathematics specialist teachers and university mathematics education lecturers. Their comprehensive agreement relates to the possible

duality of the utilitarian and the aesthetic, and the range of cultural purposes of education espoused over the decades by many including Jacks (1931) and Wilkinson (2007). The National Curriculum (2013a:3) restates this principle, requiring that a high-quality mathematics education provides “a foundation for understanding the world, the ability to reason mathematically, an appreciation of the beauty and power of mathematics, and a sense of enjoyment and curiosity about the subject”. By accommodating both utilitarian and aesthetic aspects, the respondents appear inherently to agree with the principle of reconciling the rights of the individual with the needs of society. Truss (DfE, 2014) reflected this, restating many of the OECD (2011) and National Numeracy (2012) findings about the value of mathematics, relating mastery to greater future earning power for the individual and the economic and cultural benefits to the nation.

The research question was about excellent teaching but, as was shown in the findings, the themes that arose may also be applied to the child who is the outcome of excellent teaching. Therefore this will also be a feature of this discussion. The three themes of confidence, knowledge and supererogation presented in the findings have their own distinct identities but are interdependent when considered as facets of excellence in teaching, as becomes evident in the ensuing discussion. Within the literature, greatest attention is paid to knowledge; however, the findings show that knowledge without confidence and supererogation is insufficient for excellence.

5.1.3 Theme 1: Confidence

The findings show that a key feature of excellent teaching is confidence and one way in which confidence is pivotal is when making decisions. Respondents from all groups expressed beliefs that the excellent teacher has confidence, with certainty, to reach decisions that result in the best outcome in any circumstance or situation they encounter. The respondents believed that decisions made by the excellent teacher arise from justifiable (as opposed to deluded) confidence, derived from a range of sources (including knowledge) and revealed through

several modes. For example, the respondents believed that confidence permits the teacher to make mistakes and acknowledge if they do not know; to know when pupil learning is good and when it is not (and what to do); to be flexible, creative and be prepared to take on challenges and risks. This is much as Alexander (2004) recommended. The experienced management respondents acknowledged that lack of the necessary confidence is one limitation to achieving excellence; however one HEI lecturer noted that confidence can be improved by practice. Those who were managers accepted that despite having a willingness to try, under-confidence may prevent even the cooperative teacher from succeeding.

Thus teacher confidence may be reflected in their attitude to challenge which may be allied to both scenarios two and three of the metaphor. Truss (DfE, 2014:4) observed that the new curriculum “places much more emphasis on core arithmetic – giving competence and confidence”, representing another swing in what the policy makers felt was important. As a consequence, teachers from China were to be brought in for their “can-do attitude” to show English teachers how to have high expectations and support the struggling children. The views expressed by the respondents reflected the ‘can-do attitude’ but they did not limit it to core arithmetic, exhibiting a broader view. This projects a different cultural view from that of China, noted by Daweil (2008). Another observation by the respondents when endeavouring to raise standards is the possibility that some teachers lack the confidence to allow fallibility to be a strength, not a weakness. This included the conceivable situation in which a teacher may need to acknowledge that the child may be mathematically more able than they are.

Teacher confidence was also discernible in the views of respondents from all four groups who recognised the need to be accountable, noting that all their teaching is done with an eye on the targets, a position recognised by Ernest (1998). The difficulty, the respondents acknowledged, is that they have to reconcile short-time and long-term targets and to achieve this, they need confidence. When related to the metaphor, the respondents could be comparing the undoubted success of scenario one of achieving the target in a short time to the

potential offered by scenario three, taking an unknown amount of time with an outcome that may vary from the intention. Ofsted's outstanding criteria from both 2009 and 2013 use words that may be ascribed to mainly short-term progress although this is not quantified. The Ofsted 2009 criterion had expectations that might have encouraged aspirational teaching, requiring "striking" impact with "exceptional" progress whilst the 2014 requires more prosaic "notable" impact with "rapid" and "sustained" progress. Between them, the respondents noted that their targets might range from just being able to answer a question, through ticking the boxes to show the aims of the lesson have been met, to the importance of the results at the end of the year. This short-term view could be considered as knowledge through content, which is generally not embedded and so is transient, as identified by Skemp (1976). However, more than this, the respondents recognised that the excellent teacher, despite limited independence, needs to have the confidence to go beyond the short-term targets. In particular, the experienced, management respondents felt that the excellent teacher has a long term view of success for the child but needs to temper that with the need to achieve tangible, measurable results in the shorter term.

The respondents did not present views of tangible targets beyond school, seeming to accept the standardised tests that would judge their pupils' progress. However, they knew they needed to prepare their pupils for a future that will require increasing mathematical adeptness, as identified by National Numeracy (2012), regarded by the respondents as a long-term target. They would have preferred teachers and managers to have the confidence to set goals of knowledge through understanding or "comprehensive learning" (Romero & Mari, 2011:1), demonstrated through application. Kloosterman (1996) stated that for motivation that has intrinsic value, the teacher needs to set appropriate goals and the confident teacher is able to adjust those goals to ensure best possible progress by the child. This teacher knows that some learning may take longer than intended or a different route from that which is conventional or planned in the short-term. The metaphor provides three possible scenarios with each being the possible best way to proceed depending on each child's needs with the

potential for learning for understanding through application exemplified in scenarios two and three. This supports the need promoted by Alexander (2004) for the teacher to work with the natural learning instincts of the children, creating an education which pursues high-standards but which has more breadth and humanity than previously.

Another belief from the respondents was that the teacher must relay their confidence to the children. This resonates with comments from Blishen (1969) and Aldrich (2005) that, additional to knowledge, the excellent teacher needs the confidence to enthuse and the ability to inspire and inject joy into the learning. Respondents from all four of the groups made observations that indicated that the confidence and potentially resultant flexibility of the excellent teacher is enhanced in an inclusive classroom. Here it is alright for anyone, pupils and teacher, to admit they do not understand and to know that using self-help strategies are not just legitimate, but desirable. This fallibility possessed by the confident teacher is a point particularly made by one of the student teachers. The respondents believed that teachers' embedded beliefs and motivation will contribute to the way the pupils view mathematics, reflecting the views of Mason and Johnston-Wilder (2004) and De Kock (2010). Teachers with the confidence to develop their relationship with their pupils as well as expose their own enthusiasm and creative engagement with learning will enrich the learning potential of their pupils. Several respondents remarked that teachers without confidence or conviction to promote or cope with unexpected or unintended consequences will regress into safe, limited territory, sticking with scenario one of the metaphor.

The more experienced respondents (MaST and HEI lecturers) thought that the excellent teacher has the confidence to design a creative pedagogy that will provide opportunities to promote engagement and independence. This, they suggest, is achieved through the children finding it out for themselves, joining the dots and making connections, in keeping with the aims of the new National Curriculum (DfE, 2013a). These acknowledge the interconnectedness of mathematics, requiring children to "develop fluency, mathematical reasoning and

competence in solving increasingly sophisticated problems" (p3). To achieve these aims, the respondents believed teachers also need confidence to design a pedagogy that uses affective strategies in addition to cognitive ones to draw in their pupils. Thus the pedagogical approach established by the confident teacher will contribute to the development of confidence in their pupils, whether this is allied to scenario one, two or three of the metaphor.

One aspect of pupil confidence raised by a student teacher was the need to be aware of the impact of the affective response of the pupils. The example given was of an able mathematician who was 'terrified' by a potential public humiliation. Research by Orton (1992), ACME (2008), and PISA (OECD, 2012) found evidence that, regardless of ability, teacher action that invites possible embarrassment directly impacts on confidence. This attack on self-esteem was noted as resulting in negative or anxious feelings towards mathematics.

Hence a result of excellent teaching is pupils who confidently exploit their mathematical mastery to achieve success. This becomes self-perpetuating as confidence is supported through pupils acquiring control which in turn encourages persistence and enhances confidence, establishing a cyclical model. This corroborates the research of Izmirli (2011) who found that improved confidence is gained by the children establishing control through the development of intuition and idiosyncratic strategies. By this means, the respondents believed that children who gain confidence from excellent mathematics teaching will be more inclined to take the opportunities to be actively engaged with their education, rather than passively waiting to receive. Therefore this motivation engendered by pupil confidence is another key factor in pupils' progress, confirming the view of Mason and Johnston-Wilder (2004). The respondents believed that goals based on achievement though understanding will, with appropriate teaching, generate intrinsic motivation. Therefore the outcomes are likely to reflect the pupils' realistic capability, strengthen their confidence, enhance motivation and deepen their engagement and interest. Consequently, the potential for the children to progress through a meritocratic education is improved (see Jarvis *et al*, 2003; Matheson,

2004). Although the 2009 Ofsted criteria for outstanding teaching required pupils to be inspired and challenged, reflecting the views of the respondents, neither of these requirements is within the 2013 criteria. Interestingly, both sets of criteria opened with a circular definition saying that to be outstanding, teaching was to be outstanding (resulting in pupils making “exceptional progress” (2013:32)).

5.1.4 Theme 2: Knowledge

The respondents’ views indicated that they felt that knowledge for teaching resolves into three areas: knowledge of the subject, of pedagogy and of the child. The following discussion will examine these and also the means by which such knowledge may be developed. A teacher who has knowledge of the subject is assured of understanding the progress of the children’s learning, conferring self-determination to the teacher to use what they believe are the best teaching strategies. This in turn positions the excellent teacher to make pedagogical decisions which the respondents agreed arises from confidence engendered by excellent knowledge of the subject.

There is little about subject knowledge that is mentioned by the respondents that can be disentangled from pedagogical knowledge. One student teacher indicated, without defining what she meant, that excellent subject knowledge was the mark of an excellent teacher. However, the more experienced respondents (MaST teachers and HEI lecturers) were able to articulate that knowledge of the subject means the excellent teacher knows the basic concepts and connections within and across the subject, a requirement noted by Wiliam and Thoresen (2009). This was not a new thought as the NNS (1999) arose from Ofsted’s (1994) concerns, one of which was poor subject knowledge. The respondents’ belief of mathematics as a subject of interwoven parts provides the potential for teaching that represents the child’s holistic view of the world. Perhaps, with excellent knowledge of the subject (and confidence) the teacher can avoid teaching in a series of disconnected portions and hence provide meaning and purpose to their pupils. However, as Boaler (2014) commented, England’s mathematics

policy has been “wrong-headed for many years” with a “test-driven culture”. Previously, Askew (2012) remarked that the mathematics curriculum had been designed by the policy makers and presented to pupils as a set of disconnected parts. Later iterations of the National Curriculum (DfEE, 1999; DfE, 2013a) perpetuated this despite the findings and recommendations of the Williams’ review (2008). Therefore it is tempting for the teacher to reduce what it is that they are required to teach to a series of convenient, discrete packages.

The findings show that excellent teachers are able to apply their subject knowledge to understanding what the children are doing. The teacher can listen to the child, hear what they are saying and so to diagnose and act upon what they discover. This, these respondents felt, was more than repeat teaching; it may mean retrenching to a secure position to then rebuild forward. In particular, they considered that the limitations presented by weak subject knowledge manifest themselves in lack of flexibility and inability to interpret the sometimes idiosyncratic strategies that a child might present. This view of mathematical subject knowledge emerges as central to effective teaching and learning, without which the teacher cannot fully possess excellent pedagogy. It almost directly echoes the report of Wiliam and Thoresen (2009) who noted that confident pedagogy is insufficient without the supporting subject knowledge. This also reflects the view of Ball *et al* (2001) who determined that weak subject knowledge prevents teachers from extrapolating to excellent teaching.

Being pragmatic, one of the MaST teachers considered that it is probable that even excellent teachers may have weak aspects to their mathematical subject knowledge. Then it is likely that they will regress to more formally structured lessons. The implication is that in this instance this will not be excellent teaching. However, another MaST teacher had a slightly different view suggesting that if knowledge of the subject is absent, then the excellent teacher still possesses the confidence to be able to use pedagogy effectively. Good subject knowledge can result in good teaching, which may be sufficient. Ofsted (2009) identified that teachers should possess excellent subject knowledge which is not specifically noted in the 2013 criteria

for outstanding teaching, which instead requires teachers to “authoritatively impart knowledge” (p22). This change moved from the application of teacher subject knowledge to their teaching to the delivery of knowledge to the pupil. The 2009 criterion built on Ofsted (1994) in which they expressed disquiet that the poor mathematical subject knowledge possessed by primary teachers was contributing to low pupil achievement. However, the 2013 criteria seem to have disregarded the concerns of Wiliam and Thoresen (2009) that the mathematics required for entry to teacher training was insufficient.

The views of subject knowledge expressed by the respondents initially suggested a lack of agreement on the need for excellent subject knowledge to be an excellent teacher. This gave rise to the question of whether it is possible to be an excellent teacher without good subject knowledge or if weaker teachers just do not perceive the necessity. However, on examining the context within which it was discussed, it became evident that there was a discrepancy in perceptions of what was meant by subject knowledge. Cotton (2013) considered there is both mathematics subject knowledge and mathematics curriculum knowledge which might clarify the apparent disagreements of the respondents. On one hand there was what the respondents regarded as subject knowledge in terms of knowing how to do mathematics. On the other hand there was knowledge of the subject by which they meant possession of understanding of how mathematics works, fits together and can be used. This latter definition has importance because understanding of these fundamentals needs to be transferred to the children to meet the dual purposes of their utilitarian and aesthetic futures in the changing needs of the world they will encounter.

The second aspect of knowledge is pedagogic knowledge. The respondents indicated each child will engage with mathematics differently, from the basic functional through to indulgence in the subject for its own aesthetic sake. In conjunction, Murphy (2003:125) considered that there are two forms of pedagogical realism; “objective” and “subjective”. The findings show that for greatest long-term impact the excellent teacher will endeavour to teach through

subjective realism in which the pathway to the solution may be variable and even idiosyncratic. However, the respondents recognised that for some children, and to meet short-term targets, the teaching may be objective with the teacher leading pupils down one way. Alongside this, all the respondents placed emphasis on the need for appropriate pedagogical subject knowledge to interpret the given curriculum, reflected in both the 2009 and 2013 Ofsted criteria.

Shulman (1986) presented pedagogy in two parts, pedagogical knowledge and pedagogical subject knowledge, and this had some resonance with the respondents. In particular, one HEI lecturer commented that excellent pedagogy will ensure excellent teaching, even though she had also earlier mentioned that the excellent teacher has to have really good subject knowledge. Another HEI lecturer indicated why this was important as the teacher needs to understand what it is he wants the children to understand. This understanding is particularly relevant in mathematics, according to one MaST graduate, as it is a subject where it is possible for children to get by. They can mask gaps and still make progress as, in the short term, there is no need to know why it works. However if that is the case, then the child cannot resolve any ensuing problem. The respondents agreed with Mason's (2012) suggestion that conceptual learning supported through practice, even by rote, enhances the knowledge base and recall skills. Scenario one of the metaphor provides this context with the result contributing to confident and competent application in problem solving, as long as teachers adhered to NCETM (2014) requirement that the technical proficiency is developed alongside conceptual understanding as exemplified in the other scenarios. However, the respondents did not engage in the continuing 'chicken-and-egg' debate about whether to teach procedures or discovery first (Mason, 2012).

Acknowledging and accepting the cultural bounds that determine not just what is taught but how this is done (see Brown, 2010), the respondents noted the need for good planning, as identified by Ofsted (2013). This included the excellent teacher making critical decisions about

what to teach and when, underpinned by the knowledge of the subject to understand what they are doing and why. However, additionally, one MaST teacher commented extensively that for the excellent teacher, planning is not inflexible and neither is the excellent teacher. This point was also made by one of the student teachers although this had an emphasis on the children learning to work to the teacher's expectations. The teacher draws on strong pedagogical knowledge to determine the apparent validity of the progress being made and to make judgements about how to adjust or change to ensure the most effective learning takes place. All respondents indicated the centrality of the role of the teacher and the pedagogical stance adopted. When the Meccano® metaphor is applied, each of the three scenarios require decisions to be made about the nature of the teacher's role in intervention so that pupil progress is enhanced, not inhibited. It might be considered for scenario one that the role of an adult is negligible to the success of the construction as the set procedures are undertaken but not negligible in raising awareness and providing opportunities to inspire aspirations. For scenarios two and three, the child will be starting to learn or developing the knowledge of how to make decisions about when to ask for help. The role of the adult becomes relevant in determining timely intervention such that the child is supported to be active rather than passive in meeting the challenge. An over-directive adult will remove potential learning gains and insufficient support may mean the task is not completed and motivation is reduced. The knowledge of the subject and pedagogy that the adult brings is likely to be pivotal to success in the productivity and outcomes of the challenges and hence to the child's inclination to pursue mathematics in the future. Both Ofsted (2009) and (2013) outstanding teacher criteria required regular checking of pupil understanding so the teacher is in a position to determine appropriate intervention timing and strategies. These views of the respondents correspond with the findings of Lev-Zamir and Leikin (2011) who noted that excellent teaching recognises that individual needs may vary during the lesson as well as in longer time spans, reflecting the long-term view noted by an HEI lecturer.

The respondents remarked that high quality pedagogy draws on knowledge of the subject, enabling the excellent teacher to open out mathematics beyond basics. By using creative approaches that draw on children's own experiences, the pupils find the links and take learning risks. One MaST observed that this had become easier as she had gained experience of teaching mathematics as she knew she could allow deviation from the plan because she was confident she was in control, knowing where it is going and how to get there. This concurs with Ofsted (2013) noting that the best teachers use "well-judged and often imaginative teaching strategies" (p22) and specifically for mathematics they require pupils to "think and reason for themselves" and "apply their mathematical knowledge and skills" (p9). The view from the teachers was that they were aware that in lessons that were less than excellent there is too much teaching through talk and explicit direction and not enough pupil activity. Active pupil participation with the mathematics requires a carefully planned, flexible approach, balancing challenge with support (Brown, 2010). However, the respondents acknowledged that this constant and demanding effort from the teacher to ensure the children are active learners is an expectation that not all teachers were willing or able to meet. The respondents suggested that additionally, the excellent teacher reflects upon what they create in their primary mathematics classroom, a point made by Askew *et al* (2010), amongst others. This way the teacher knows what contributes to effective, relevant learning to ensure that it is the best possible environment in which all are valued and the pupils can thrive. Without making these efforts teachers are pedagogically limited and therefore will not or cannot permit pupil freedom, so reducing pupil engagement.

The third aspect of knowledge is knowledge of the individual child. The respondents were all convinced that the excellent teacher possesses an in-depth awareness of what each child can do and so knows of any issues or gaps, knowing when a child is missing something and being able to return to basic concepts, if necessary. They believed that, as a consequence, good knowledge of the child enables the teacher to avoid endeavouring to build on what is not there or to avoid unproductive repeat teaching. This is not easy in a class with many varied

demands on the teacher but the excellent teacher goes beyond just managing the class. The excellent teacher, who knows the child and the subject, is able to maximise each child's attainment. The principles of mastery proposed by NCETM (2014) indicate that all but a few children will work at the same pace on the same tasks. However Orton (1992) and Turner (2013) reasoned that there are differences between people across all human pursuits, so why not in mathematics learning. The different rates and pace of learning have been recognised in the national curriculum since 1962 (Brown, 2010). In the face of these conflicting views, one respondent strongly believed that setting was a solution to multiple demands, acknowledging different levels of capabilities, views also expressed by Krutetski (1976) and Betts and McNaughton (2004). However, Hardy (2007) warned about regarding apparent ability too simplistically, noting that there is evidence that less visibly motivated pupils are often deemed less able and vice versa. To manage these individual needs effectively the respondents returned to the need for the teacher to have strong knowledge of the subject so they know, if appropriate, where and how the pupil's mathematics has gone wrong. By this means the excellent mathematics teacher treats the cause not the symptoms, determining and delivering what the child needs to expedite progress. This is undertaken either immediately within the lesson or later, through reinterpreting plans, using annotations to show the individual needs of the children, what they know and how they should progress.

Interestingly, one student teacher felt that the able child needs to be taught by a teacher with excellent subject knowledge but this is not necessary for those with special education needs (SEN). This illustrates one of the inequities identified by Ofsted (2012) and highlights the naïve student teacher's lack of understanding of the complexities of the needs of the child with SEN. As the findings show, to achieve the best teaching for all, the links between confidence, knowledge of subject, pedagogical and the child are inseparable. In contrast, one experienced respondent understood the issues, expressing concern that excessive support for children with SEN is to the detriment of development of independence, exacerbating their SEN status.

As the respondents commented, knowledge of the child allows teachers and pupils to be jointly proactive in furthering the pupils' beliefs and attitudes about mathematics. The teacher who both values the pupils and uses knowledge of how children learn mathematics projects a positive image about mathematics. This combination, Ernest (2008, 2011) and Boaler (2012) noted, promotes engagement and hence motivation and progress. The respondents believed that children can have a direct, positive effect on their attainment. To promote this, excellent teachers use their knowledge of the child to provide opportunities for children to be given responsibility to self-determine the direction of their learning, develop their own expertise, and view themselves as mathematicians. Ofsted (2009) proposed one method to achieve this in the criterion requiring the teacher to ensure that children know how to improve through the use of dialogue. However, more recently, Ofsted (2013) merely requires one directional 'constructive feedback', illustrating a withdrawal to more functional expectations.

5.1.5 Theme 3: Supererogation

All the respondents from student teacher to HEI lecturer believed the excellent teacher goes beyond that which is required to meet prescribed markers of success. As a result, the child will also do so. Each will challenge himself, have improved thinking, derive enjoyment from mathematics which generates motivation and possess pride in his achievement. Krutetskii (1976), ACME (2008) and Wiliam and Thoresen (2009) reasoned that the status placed on mathematics indicated its value and purpose but added to this that mathematics has the capability to be more than prosaically functional with the power to generate elation and joy. This reflects the comments particularly of the HEI respondents who, with the longer view in mind, wished the children to have pleasure and pride in their achievements. Additionally, they believed that by enthusing about and valuing the mathematics and gaining an appreciation of success through persistence and tribulations, these pupils perceive an overt relevance in school mathematics (see Brown, 2010 and Mason, 2012).

Boaler (2012) argued that for children to learn advantageous life skills, they need to learn responsibility for making sense of mathematics from an early age. To reach this state, the respondents believed that the excellent primary mathematics teacher will ensure that children are proactive in their learning, prepared to 'have a go', moving at least into scenario two of the Meccano® metaphor. This will encourage them to assimilate real mathematical understanding; develop number sense; be prepared to take risks and choose to persist, using what they know, including those tools learned by rote, to find what they do not yet know. More than just achieving goals, one teacher respondent thought the children should be creating and solving their own problems, demonstrating supererogation through the third metaphor scenario. This was extended in the comment from one HEI lecturer who wanted to 'liberate' the children; a desire to grant agency. This is perhaps intimating a belief in the potential for all to benefit from an egalitarian education towards the possibility of improved human capital, future prospects and upward social mobility.

The more experienced respondents (MaST graduates and HEI lecturers) acknowledged that there is not complete freedom to teach in a way they believe to be excellent. However, through supererogation, excellent teachers endeavour to ensure they optimise the pupils' opportunities. Ideally the required short-term and long-term goals would both be achieved through the nature of excellent teaching espoused by the respondents; one MaST teacher was able to say that there is some evidence of this emerging through the strategies implemented in his school. However, this may not always be so and in this situation, teacher confidence is exhibited through pragmatism and compromise. The respondents acknowledged that their perspectives of excellent mathematics teaching alone might mean that the targets required by the school for accountability would not necessarily be met. For example, they knew that, in keeping with the metaphor scenario one, ticking boxes is not sound evidence of pupil knowledge or understanding, with meaning deferred to the future (see Mason, 2012), but recognised the need for adherence.

The respondents appreciated that much could be done to meet short-term targets including teaching on separate aspects of mathematics to raise attainment. However, they believed this strategy would be counteracted by a reduction in engagement, enjoyment and intrinsic motivation, which will have an impact in the longer term, echoing Williams (2008). They did not express thoughts that perhaps a child might be motivated by being content with achieving in the mode of metaphor scenario one. The views of the respondents on the limitations of teaching solely to meet short-term, functional targets are affirmed by the findings of PISA. They stated that higher scoring children “are open to solving mathematics problems – who feel that they can handle a lot of information, are quick to understand things, seek explanations for things, can easily link facts together, and like to solve complex problem” (OECD, 2012:18). Through supererogation, potential limitations are ameliorated.

The pedagogical approaches propounded by the respondents leaned toward ‘relational’ (Skemp, 1976) and ‘connectionist’ (Askew *et al*, 1997) principles. The respondents acknowledged the three views of mathematical knowledge identified by the National Centre for Excellence in Mathematics Teaching (NCETM, 2014): factual (to know that), procedural (to know how) and conceptual (to know why). They believed that all of these were needed for an excellent mathematics education, reflecting a view that might be allied to the value and purpose of all three metaphor scenarios. One of the MaST respondents especially identified experiential learning as a means to creating true understanding rather than copying and performing and so children are inspired to learn. She expressed particular and personal views about how children learn mathematics, strongly believing that it is not possible to make a child learn mathematics and the teacher, however excellent, cannot make it ‘go in’. With this in mind, she expected the excellent teacher to create the best experiential opportunities so that learning will be optimised, avoiding use of procedural prompts, going above and beyond routine teaching. As Nooriafshar (2004) and Mason (2012) speculated, with agency and opportunity children may develop understanding to a more advanced or deeper level than in less engaging contexts where the mathematics is being taught through meaningless activity.

The respondents expressed other views that are indicators of supererogation as a feature of excellent teaching. They talked of high expectations, meeting the needs of individuals, recognition of potential and mutual respect. One suggestion from an HEI lecturer was for the teacher to demonstrate their subject knowledge through presenting themselves to their pupils as a mathematician, an idea proposed by Mason (2012), creating a community of practice. The respondents also noted the need for a passion for mathematics that enables the teacher to be the mathematician model in the classroom, creating experiences where children learn and understand. Moreover the teacher needs to be aspirational and inspirational, creating and developing these same traits of supererogation in the children, not just for the short term but with an eye on future careers and citizens.

In summary: These perspectives illustrate the respondents' beliefs in the value of discerning the needs of individuals and choosing appropriate teaching strategies, supporting supererogation through application of confidence and knowledge. These are part of the teacher's beliefs about what the children need to learn, why they need to learn it and how that is to be achieved. These beliefs support the excellent teacher with a feeling of security that the ways they are teaching will not only meet the necessary targets but that the outcomes will be better than by other means. Supported by confidence, the respondents suggested that the excellent teacher uses knowledge of subject pedagogy so that planning is not constraining, freeing the teacher to draw on their knowledge of the individual needs of the children to be flexible for optimum success. One outcome will be that the teacher will enable pupils to develop "active mathematical identities that include self-belief as well as adaptive expertise" (Boaler, 2012:61). An additional dimension evident from the interviews was that teachers bring their own values and beliefs about their pupils to their teaching, an aspect noted by Askew *et al* (2010). As Mason and Johnston-Wilder (2004) commented, these embedded elements of the teachers' identities direct their relationship with their pupils, and will contribute to the way the pupils view mathematics. One example of this was from those respondents who commented that excellent teachers have high expectations of themselves

and their pupils, implying that such teachers will have pupils who achieve more highly than those of teachers who do not hold these beliefs.

5.2 Part 2

Dichotomies

Whilst analysing the findings of the research, two apparent dichotomies surfaced. The first concerns the dual purpose in delivering excellent teaching for both the intrinsic motivation of the child as a learner and for the extrinsic incentive of using the child as the vehicle or instrument by which success is measured. The second questions whether it is the teacher's beliefs in the child that informs intended outcomes or if the required outcomes inform what is asked of the child.

5.2.1 Teacher beliefs: the role of the child

The first dichotomy is that the role of the mathematics teacher in delivering excellent teaching is both for the intrinsic motivation of the child as a learner and for the extrinsic incentive using the child as the means to measure success. Connected with this is the use of both long-term views to meet the needs of the child and society and short-term views to meet the needs of the government education targets. The long-term view produces individuals who are mathematically competent and confident to make positive contributions to the economy. It also delivers the more unquantifiable creation of people who choose to pursue mathematical activity because of the intrinsically pleasurable motivation and aesthetic value of the subject. It is likely that at least the MaST graduates and HEI lecturers would have read about and incorporated these deliberations into their writing and planning for teaching. However it was either so entrenched in, or so remote from, daily practice that it did not surface discernibly through the interviews when the respondents considered the question of excellence in mathematics teaching. However, it was clear that they were aware of Orton's (1992) concerns that endeavours to meet the needs of all may result in difficulties getting it right for many.

In their responses all respondents recognised the acknowledged, evident need for children to meet the short-term targets set. However, they believed the mathematics with which the children should engage whilst working towards these targets is not necessarily that which is prescribed by published policies and guidance. Measures of outcomes that show that children have mastered the basics of arithmetic were viewed by the respondents to be important but only as a starting point. This reflects the views of Hopkins *et al* (1999) and Hughes and *et al* (2000) who commented that mathematics taught in school needs to enable pupils to transfer and use it in a range of contexts, whenever needed. Scenario one of the metaphor suggests the consequence that if the completed model is left on show, it serves no purpose other than as tangible evidence of temporary achievement. If deconstructed, then the bridge can be rebuilt many times, using the instructions and, over time, some stages will become memorised and the task will be completed quicker, if the child does not become bored with the repetitious activity. If at some point parts get lost, then the bridge cannot be built to the same standard and may, in the end, not be self-supporting. This concurs with concerns in the literature about the complexities of endeavouring to measure success as well as acknowledging that poor numeracy is unacceptable at an individual, national or global level (Suggate *et al*, 1998). So for all children, mastery of these basics needs to be the minimum achievement. However, as Koshy and Murray (2002) observed, these learning acquisitions will only be transitory, short-term and will not embed long-term unless used and applied as tools for the child to employ when engaging in mathematical activity.

5.2.2 Teachers' beliefs: outcomes and targets

This leads to the second dichotomy which is whether it is the teacher's beliefs in the child that informs intended outcomes or if the required outcomes inform what is asked of the child. Williams (2008) reflected that good teaching needs a good curriculum to be successful but teachers have no control over this. This is illustrated by the 1999 introduction of the term numeracy as the underpinning principle of the curriculum, only for it to disappear sixteen

years later. However, as Orton (1992) maintained, the role of the teacher is more important than the curriculum or policies. It may be that this dichotomy is reconciled by the teacher selecting the processes by which the outcomes are achieved. The respondents indicated that the excellent teacher will take the curriculum they are required to teach and embed their person values and beliefs into interpreting how it will be taught to achieve the best outcomes (Ernest, 1991, 2008). One possible solution offered by the respondents was to teach the children in ability sets so that different teaching strategies might be used as appropriate for the needs and abilities of the children. In particular, there was some thought from the respondents that a more directed, instrumental teaching approach was best for the less able, with relational learning reserved for the more able. However, as Brown (2010) noted, this approach showed little improvement for the least able in tests so even short-term success was limited. The predominant approach advocated by the respondents was to develop relational understanding but, as Hughes *et al* (2000) were clear, this is not an easy option. The Meccano® metaphor scenario three offers this perspective but both teaching and learning are complex, requiring knowledge, confidence, persistence and ingenuity. It may be that scenario two is sufficient and manageable.

The respondents did not distinguish between outcomes and targets but their views might be interpreted that outcomes should be goals that would motivate and so perpetuate engagement and effort. Formative assessment can help teachers and pupils make progress (Barmby *et al*, 2009), and the respondents noted one of the skills of the excellent teacher is to decide when to intervene. The respondents were clear that the excellent teacher would work to achieve what they believed to be the best outcomes for the children, whilst also endeavouring to meet the targets necessary to reflect the school in a positive light. These targets are set by or for the school to interpret the expectations of those external agencies with the remit for and control over the education systems. However, as National Numeracy (2012) observed, the future for these pupils is not yet defined. The respondents

accommodated this dilemma of demands through an amalgam of idealism and pragmatism. They acknowledged minimal teacher independence and thus it might be construed that, yet again, the excellent teacher is willing and able to reconcile possibly conflicting demands. They select the processes by which the outcomes are achieved, reflecting any or all of the three scenarios set out in the Meccano® metaphor, drawing on knowledge of the individual needs of the children.

Although Brown (2010) noted the idealism by which education is a driver for social mobility is flawed through a range of inequities, it is clear that the respondents believed that excellent teacher will endeavour to provide opportunities for all to achieve. They were aware that, as Ofsted (2008, 2011, 2012) reflected, too often teaching is limited with few opportunities for children to develop skills in application of mathematics. The approaches the respondents proposed interpret their reflection of how society functions and the direction in which it is moving, suggesting that the excellent mathematics teacher tries to uphold and further the children's cultural future. This provides the potential for growth that will both altruistically enhance the individual's quality of life and also, perhaps as a consequence, be of more prosaic benefit to society (Koshy & Murray, 2002).

5.2.3 Becoming excellent

There was not consensus about the capabilities of all teachers to become excellent or indeed the need for all teachers to do so. Some respondents agreed that, despite the ACME (2008) recommendation that teachers should be allowed to make decisions about pedagogy, not all teachers are capable of this. Conversely one respondent was convinced that all teachers have the potential to be excellent. In this, she agreed with Williams (2010 & 2012) that mathematics education is not paradoxical, and that we need to expect teachers to be bold in their approach to teaching mathematics and gain big outcomes rather than just small successes. The onus for all teachers to be excellent was questioned by one MaST teacher and a student teacher, who felt that it is not necessary as good-enough teaching will achieve the

desired outcomes, particularly with the support of well-chosen and well-used resources (Anghileri, 2001). Other respondents considered it differently, suggesting that although it might be desirable for all teachers to be excellent, it was not achievable or realistic, at least not all the time.

Respondents who held management roles worked to develop each teacher to be excellent, acknowledging their responsibility to pupils to ensure they get good quality teaching at all times and to avoid perpetuating differences and inhibiting change (Askew *et al*, 2010). Their approach reflected the principle noted by Alexander (2004), De Kock (2010) and De Geest (2011) of CPD combining training with research and reflection to achieve excellence. As Brown (2010) noted, there have always been concerns about teachers' number skills, and so there are, according to the views of the respondents, some things that can be learned to move towards excellent teaching: addressing poor or inconsistent mathematics subject knowledge and pedagogical subject knowledge, with a view to enhance teacher confidence and attitude, endorsed by Ofsted (2012) and Williams (2008). This would indeed be effective and sufficient if, to be excellent, teachers just need to learn a series of competencies and teach to the test, a view considered by Wragg (1993). However, this is a limited view of mathematics, which is better seen as connections between concepts within relevant contexts (Barmby *et al*, 2009).

The management respondents endeavoured to create a collegial, supportive environment to which individuals felt they could commit, with a sense of cohesiveness and progression through the school, supported by a bank of accessible support materials. This was intended to contribute to better understanding and hence improved confidence and better teaching (Turner & McCullough, 2004). PISA (OECD, 2014) noted better pupil performance in schools where teacher accountability is a feature and where there is greater collaboration between teachers and management. Staff development allows teacher to be both initiators and receivers (Alexander, 2004), reflecting Wenger's view that the exercising of power in communities of practice is "horizontal, mutual, negotiated, often tacit and informal" (2010:8).

Despite this endeavour to include teachers in their own development, there are other barriers. One respondent view was that teachers' failure to improve may be based on apprehensions about their subject knowledge. From the time they are trainees, primary teachers exhibit insecurity about mathematics, limiting their ability to learn mathematics specific pedagogy and to develop confidence that can be transmitted to their pupils (Cotton, 2013; Haylock & Manning, 2014). This may be compounded by the guilt teachers feel about their lack of mathematical confidence (Haylock & Manning, 2014) and the particular beliefs pertaining about mathematics (Suggate *et al*, 1998).

The respondents admitted that if CPD questioned the *status quo* of the community of practice that would be one barrier to every teacher becoming excellent, a point raised by Bjuland and Jaworski (2009). Teachers benefit from undertaking research as they can then place a theoretical framework onto their practice. However, the confidence, trust and courage identified by De Geest (2011) as positive outcomes of CPD may not extend to all if teachers' security in current practices (noted by Mason, 2004) is questioned and challenged too far. The respondents identified this as one reason why there might be a lack of teacher achievement or improvement, with a particularly illuminating example from one HEI lecturer who had previously been a local authority advisor. She (and other respondents) highlighted that some are not willing to persist and be flexible so may not be able to cope with inconsistencies and idiosyncrasies they may encounter from the children (Brown, 2010). They prefer to remain in their comfort zone, especially if they are achieving short-term aims, a conclusion reached by Mason (2004). Associated with this is a belief held by some teachers encountered by this respondent that open, problem solving lessons would not meet the desired targets, and so they were resistant to change their practices. Over time, there has been fluctuation between teaching for procedural and conceptual understanding (Brown, 2010) so it may be that teachers believe change in their practice is not necessary.

5.2.4 Excellent and good enough

Within the views of excellence put forward by the respondents, there was reflection on the difference between good and excellent. Whilst they all believed that excellence is highly desirable, they debated whether it is essential, necessary or achievable by all teachers. Interestingly, Askew *et al's* (1997) seminal work considered effective, rather than excellent teachers. In particular, there was a sense from the respondents that for the most part, a good teacher would provide appropriate learning opportunities for children to meet the necessary targets. Within the Meccano® metaphor, scenario two provides a safe balance between repetitious, passive engagement with the construction in scenario one and the more precarious potential for either success and failure arising in scenario three, risking exposure for the teacher as well as the children. Although the choice of words by Truss (DfE 2014:4) for teachers with a “can-do attitude” suggests high aspirations, it might only fall within the principle of ‘good-enough’ expressed by the respondents; the other words chosen by Truss were “core arithmetic” and children becoming “competent and confident”. In addition, it may be that by maintaining a ‘good-enough’ approach to teaching, children are subjected to an even-handed, consistent mathematics education that prevents disruption from the vicissitudes of policy change (Anghileri, 2003). To support this, Brown (2010) commented that teachers use good sense in continuing to teach the basics, regardless of the swings of the pendulum.

Several issues arise about targets applicable to those who determine them. After all, primary schools met that which was required: in 2013 the floor standard for KS2 SATs was 65% to reach the benchmark and 85 % was achieved (proposed for 2015 is 85%). However, for GCSE the floor standard was higher at 73% with achievement below at 70% (DfE, 2013b). It must be questioned how the year on year increase at both stages has been achieved. It may be through improved teaching but also might be due to adjustments to the assessment (nature and content), the marking rubric or the normalised scale applied to results. The reduced achievement at GCSE supports one finding of this research which showed that closer

consideration should be given to the appropriateness, relevance and justification of the targets, both level and type. Targets in primary school can be met by less than excellent teaching so it seems that it is not necessary to teach better, especially if not all can be excellent and 'good enough' is sufficient. The second Meccano® scenario shows that satisfactory progress can be made. Nevertheless, the key theme of supererogation highlights that aspiration to be excellent should not be subsumed within success from a satisfactory performance.

One student respondent suggested that the best teachers should be used to provide best for the most able children, reflecting what she had observed in practice. After all, both Krutetskii (1976) and Ofsted (2012) stated beliefs that the future of the more able is to be the problem solvers and the less able to be the basic calculators, reflecting the scenarios in the Meccano® metaphor. However, this was identified as an inequity by Ofsted (2012) who noted that less able children get teaching assistants or the least experienced teachers when all children are entitled to a good teacher. Another inequity noted by Ofsted (2012) was of the best quality teaching occurring prior to test times. This could, the respondents acknowledged, mean that learning could be superficially acquired for the short-term. However, they indicated that the teaching by which learning becomes embedded takes place as a continuous, sustained, high-quality process. The respondents did not even allude to the potential for adverse influence by the overtly motivated child or the socio-economic backgrounds of their pupils, inequities observed by Hardy (2007) and Brown (2012).

These examples indicate that within the communities occupied by the respondents, the excellent teacher transcends potential, adverse influences with the capacity to create inequities. They may not have consciously identified the broader views of education beyond the classroom but these were implicit within the responses. The community to which the respondents belonged (or were about to join) provided them with the 'situated expertise' of their communities of practice, as identified by Wenger (1998). The agency they gained

through their identified roles of teacher, manager and mathematics educator bestowed justifiable 'guild knowledge' (Sadler, 1989), acknowledging the status they had achieved within their community. This would offset the potential limitation arising from their culpability to that community making them "vulnerable to its power plays" (Wenger, 2010:9). The occasional stumbling articulation might be interpreted as an endeavour to express the longer-term view of the purpose of primary education in general and mathematics in particular; issues such as values, quality, projected societal and economic needs and social mobility (Alexander, 2000, 2007). It might also be that these are the expressions that exposed the importance or significance to be attached to the intangibility of excellence.

5.3 Part 3

The respondents

It is worth considering the reasons for the beliefs expressed. The biographies show some of the participants' own experiences of mathematics in their education through school, ITT and any subsequent CPD. Their experiences of mathematics in school were variable with some negative, some neutral and some positive. This influenced their decisions whether or not to pursue mathematics further as they moved from school. However, by the time they took part in this study, they had all reached the stage of being advocates of excellent mathematics teaching with a suggestion of evangelism in their motivation. This included the student teachers who, by the time of the second interview, had placed a practical and theoretical understanding onto their initial views expressed in their applications and interviews, developing their philosophy of education and professional identities.

5.3.1 Respondent backgrounds

The backgrounds to the respondents may provide insights into their views of excellent mathematics teaching. Within each of the groups there were respondents who had either smooth, positive experiences or variable encounters with mathematics in school. Both those

respondents with affirming experiences and those with inconsistent school experiences gained sufficient confidence to perpetuate or to develop their affinity with mathematics. They met Mooney *et al's* (2012) view that society needs both functional mathematics and an appreciation of the aesthetic elegance of mathematics. Whether through a continuing or latent interest in mathematics, all drew on their histories to develop a determination to improve primary mathematics teaching. Their responses to their situations may be considered from four viewpoints: the teaching they received; the purpose of mathematics; pedagogy and goal motivation; family background.

For example two of the three MaST graduates chose their mathematics pathways at school as a direct result of the teachers they encountered. For one, the teacher she did not like made her realise the impact that teachers can have, a point made by Askew *et al* (2010) and Aldrich (2005). This teacher's experience was then turned to the positive response of deciding to be an excellent teacher. The other MaST graduate had a different reaction; she gained poor results and despite loving mathematics chose not to pursue it further at school.

The third MaST graduate had a neutral, satisfactory experience of mathematics throughout his education, encountering uninspiring teaching, resulting in having no strong feelings either way but being sufficiently successful. His success relates to comments by Williams (2008) that teaching to the test may be successful but curtails enjoyment. This teacher only learned about mathematics from others more experienced when he became mathematics co-ordinator. Another example is the student teacher who repeated failed in mathematics through school but when she had a need for career development, she was successful, reflecting Kloosterman's (1996) observations on the motivational value of goals. For neither of them what and how they were taught in school had much relevance or purpose and their lack of progress reflected the importance of motivation (Orton, 1992; Mason & Johnston-Wilder, 2004). Both the teachers at the start of their mathematics leadership experiences had found they were teaching the older children through default but realised they were successful

and then enjoying it. Their goal then became the MaST course which met the needs of both their management role and their aspirations to help other teachers to become better.

One HEI lecturer had a positive primary school experience, when the purpose was evident, but was miserable and mystified by secondary mathematics. She was in danger of falling prey to an acceptable norm of incompetence and dislike for mathematics (Harris, 2012). Her teachers failed to engage her intellectually and creatively, providing no obvious relevance, noted as failings by Mason (2012) and Wragg (1993). However, night school and her initial teacher training (ITT) both offered a different experience and from there she progressed upwards in her mathematics education career, gaining confidence with an apparent evangelistic view. This illustrates the ACME (2008) point that learning mathematics needs to be about more than achieving levels at certain ages, and should include finding an aesthetic value.

Two of the HEI lecturers had family backgrounds in mathematics and education. One of these had a poor time in primary school but blossomed in secondary although she had no memory of any particular influence from her teachers. She pursued mathematics thereafter perhaps illustrating the influence of her cultural and human capitals. The other HEI lecturer also drew on her heritage as she sailed through the mathematics at all stages of her education but then followed much the same career and belief pathway.

All respondents developed their views and personal philosophy of mathematics teaching throughout their lifetimes endorsing the views of Matheson (2004) and De Kock (2010). Thus their educational, cultural, personal and professional experiences will have formed their identities as teachers of mathematics. The unfixed nature of these identities through their education and careers illustrates how identity may move and adjust to accommodate the changing world in which teachers need to function (see Hanley & Darby, 2006). The respondents showed that the excellent teacher is proactive in that they subscribe to and have personal agency in the process of identity creation. As Wenger (2010) noted, within a community of practice, even if all is not harmonious, this agency cannot be subsumed by even

the most assertive imposition of internal or external power. The experiences of the respondents occurred inside a series of communities of practice over different times and places, within which they were sometimes passive and at other times active. From this arose their beliefs about the key elements of excellent teaching, such as confidence, knowledge and supererogation.

All respondents, regardless of their pasts, were resolved to teach both for optimum academic success and for aesthetic pleasure in mathematics. It seems that for the respondents, affirmative experiences promoted a desire to pass this on to children, perpetuating the positivity. Negative mathematical experiences in their pasts created a determination that children should not encounter those practices or any others that inhibited progress in and enjoyment of mathematics. Thus they avoided the dislike, under-confidence and guilt identified by Suggate *et al* (1998) and Harris (2012) and, having worked to overcome their negative experiences, are likely to have become empathetic teachers (Mooney *et al*, 2014).

One variable was the length of time that the respondents had been teachers and hence when they undertook their ITT. Within each group there was a difference with the overall range being from nought to twenty seven years' experience in teaching. During this time approaches to ITT had moved from individual HEIs determining their curriculum to the introduction of national teaching standards in 1998 with later revisions. Yet within the MaST graduate group, for example, with a range of eighteen years in teaching, the fundamental ideological stances expressed by the most and least experienced indicated little difference. The primary mathematics education they had each undertaken will have varied according to the policies current at the time, particularly to the change evidenced after Plowden (1967) and Cockcroft (1982) when instrumental learning was reduced in favour of relational learning (Brown, 2010). The main distinction was that those with more years in teaching projected a more overall managerial acknowledgement of meeting targets with an acceptance that those targets were determined by Ofsted and league tables. This was not unreasonable, given that

for one, his main role in school prior to the MaST course was managerial although this was not reflected in the comments by another, a recently appointed head teacher.

Therefore, it might be deduced that the respondents' views of mathematics teaching were influenced by the courses they had undertaken (or were undertaking). One illustrative example of this development is a teacher interviewed at the start of the MaST course and a year later. Despite being appointed to the school specifically to raise standards of mathematics, she acknowledged that she had changed the way she taught as a result of what she had learned and read. Interestingly, in her first interview, she expressed beliefs much as others had done but her comments in the second interview suggested that previously she had not been acting upon those beliefs. Respondents from both the MaST groups stated that there was an improvement in both pupil engagement and their understanding of mathematics, reflected in both formal and informal assessments, providing evidence-based justifications for the teacher's practices.

5.3.2 Common thinking amongst respondents

The views of the HEI lecturers often projected a wider view of the issues around mathematics teaching than did the school-based respondents. One lecturer asserted that the university environment with an embedded expectation of research is what attracted her to the role. This reflected their broader range of related experiences than those of the other participants, having been teachers, managers in school, advisory consultants and then university lecturers. It is worth noting at this point that, despite the low importance placed by the government (2010-2015) on HEI roles in teacher education, highlighted by scant mentions in the white paper (DfE, 2010), they endorsed the MaST programme, established by the previous government although central funding was removed (DfE, 2011). It may, however, be inferred that this suggests that this response recognised the status afforded to a qualification that was accredited by a university, rather than the expertise brought by the lecturers.

The literature drawn on for this study encompassed that which the HEI lecturer participants may well also have read, which will have influenced their thinking and in turn the student teachers and the MaST students. In particular, they will have been aware of changes that had occurred periodically in the policies that informed the curriculum and hence, what was expected of the teachers (Brown, 2010; Haylock & Manning, 2014). They were also the people who drew on their experiences, research and reading to write and teach the MaST course. Therefore it would be unexpected for those on the course, by the end, to have fundamentally different views from those who taught them. Even so, this possibility could not be discounted because, as a university accredited postgraduate course, the participants were required to engage with evidence, both secondary and empirical. They were also required to make up their own minds about what the evidence meant and to justify the conclusions they reached (QAA, 2008). It may be inferred that they undertook the course because they already believed in the message projected in the recruitment material, which was drawn from the government brief. Alternatively, at the time, it was a government requirement for all schools to have a MaST so the choice was perhaps that they were nominated by their schools as teachers interested in excellent mathematics teaching.

Wenger (1998) expressed that a social theory of learning has four main contributory premises: of community within which learning arises from belonging; of practice to develop competence; of identity grown by becoming part of the community; of gaining meaning through situated experience. The respondents tacitly subscribed to these principles for both the teacher and for the child. However, the indications were that they accepted that their independence has to be curbed to meet the needs prescribed by the community of the school which in turn is directed by the political diktats. Ernest (1991) also had four main aspects that contribute to a philosophy: of the subject; the nature of learning; the aims of education; the nature of teaching. It could be argued that the culture of teacher education, both initial and continuing, encountered by all participants during the last twenty seven years, subscribed to similar theories within these areas. This could account for the findings predominantly agreeing with

the literature; however, embedded within the responses there is evidence of independent, evidence-based thinking.

5.3.3 Respondents' stance

The respondents from all four groups reflected on the acts, personality, and character of the excellent mathematics teacher, including the need to be realistic, pragmatic and fallible. They agreed that pupils thrive best if they are proactively involved with mathematics, rather than being 'outside' whilst mathematics teaching is done to them. It might be deduced from Meighan (1986) and Ernest (1991) that a characteristic of excellent teaching is that it is agentic in interpreting the ideologies of the school and the wider educational context to provide the desired education. The respondents' identities were informed by their personal philosophy and ideology, rather than by the school or wider political contexts. To achieve excellent outcomes and meet the needs of the individual and of society, the teacher's individual professional identity is central.

Llewellyn (2012:397) asserted that there is no one way of teaching mathematics which will work alone and there is not one that is necessarily better or worse than another. This was developed by Orton (1992) who noted that teachers may well be working alongside colleagues who held quite different views on the best way to teach mathematics. To accommodate this conundrum of decision, the respondents indicated that each teacher should examine their personal views and representations critically and reflectively, exercising confidence, knowledge and supererogation. Thus their identity is formed through a combination of unique professional and personal factors and arising from the range of factors that have brought them to being a teacher against the range of beliefs documented (see Askew *et al*, 1997; Ernest, 2008, 2011). This way the teacher knows what contributes to effective, relevant learning in primary mathematics to ensure that it is the best possible environment within which the pupils can thrive (see Carr, 1996; Bloomfield and Harries, 1999; Askew *et al*, 2010)

Although none of the respondents mentioned ideologies, identities or philosophies, and did not state affiliation with any particular theory of learning, their views and beliefs reflected a social constructivist philosophy of mathematics education. Askew *et al* (1997) observed that teachers possess personal philosophies so although a teacher's theoretical stance may not be specifically articulated, it may be evident from their actions, drawing on experience, and continuing development (Orton, 1992; Turner & McCullough, 2004). As propounded by Ernest (1998, 1991), endorsed by Mason and Johnston-Wilder (2004) and exemplified through the Meccano® metaphor social constructivism involves conceptions of the learner, of knowledge and the relationship between them. The respondents presented a cognitive, constructed view of learning which occurs while participating in and contributing to the context or situation where it takes place. They held that knowledge is not passively received but is actively built by individuals through participation in and enculturation into social practices, assuming a close connection between knowing and doing, contended by Ernest (1998), Wenger (1998) and Boaler (2012). The indications from the respondents were that they did not believe cognitive processes are subsumed by social and cultural processes, a socioculturalist position. Therefore, although the viewing lens for this study has reflected the socioculturalist stance propounded by Wenger (1998, 2010), the comments from the participants implied that they tacitly subscribed to a social constructivist philosophy (see Ernest, 1998).

5.4 Conclusion

Certainly, the range of thoughts and comments from these respondents gives an impression of overt and pragmatic compliance laced with ideals of non-compliance if their beliefs are counter to the presented norm. There is not a sense of resistance to conformity when that is deemed the best course of action but, rather, an intent to promote non-conformity principles where the evidence indicates this is appropriate. This gives an evocation of a community of professionals with an underpinning confidence in teacher professionalism and knowledge of what is right. They suggested that the excellent teacher's world is one that accommodates

and interprets policy changes rather than one of reactive disobedience or passive obedience. This allows accommodation of the short-term benefit to the school in terms of the child meeting the targets set or for the longer term benefits of optimum development of the child. Here the knowledge and confidence of the teacher plays a part in determining how they reconcile the various demands on their professionalism with their professional and personal identities.

The respondents commented most about knowledge, but it is evident that without confidence and supererogation, excellence is not achievable. It also seems that confidence and knowledge alone may be sufficient for 'good enough' teaching, but neither confidence and supererogation nor supererogation and knowledge without the third theme is enough for even 'good enough' teaching. From this it might be concluded that the embodiment of excellence is embedded in teacher confidence, identity, ownership and agency within the process and product of possession of interactive knowledge of the subject, of pedagogy and of the child, enhanced by the aspirational application of supererogation. Excellence must be nurtured, becoming developmental and accountable and it is within and enacted by the child who is the outcome of excellent teaching.

Chapter 6 – Conclusions and recommendations

This final chapter draws conclusions from the findings, considering how the study contributes to the body of knowledge in the field of teacher education and the substantial contribution it makes to the theory and practice of education. The research drew on the views of those endeavouring to create excellent teaching, generating data that arose from participants' beliefs underpinned by their personal experiences and education. Therefore it is reasonable that their views were valid within the context of their experiences so whilst they cannot be generalised, they can be applied to other contexts. Also included are reflections on the research process, the limitations of the study and implications for further research.

6.1 Addressing the research aim

This research had a single question: 'How is excellence in primary mathematics teaching perceived by primary teachers and mathematics teacher educators in England? The analysis revealed and illuminated unexpected, surprising, interesting and new perspectives. The main outcomes of the research were:

- three interdependent themes which contribute together to create excellent teaching in primary mathematics;
- two dichotomies exemplifying the complexities of teaching;
- the interesting perception of 'good enough' being sufficient to meet targets.

The application of the three themes and metaphor as a unique representation of the views and ideological stances of the respondents to the sometimes seeming elusive unquantifiability of excellence which also emerged from the data, gives the possibility of making the characteristics of excellence explicit so reducing intangibility.

The heart of the research is the three key themes that arose (confidence, knowledge and supererogation) which are not discrete but interwoven and interdependent. These strike a

chord with the teaching profession, acting as an aid to articulating what is embedded, implicit guild knowledge. The dichotomies and the notion of 'good enough' highlight the professional conundrums that teachers encounter. They have to reconcile their professional identity and beliefs with the exigencies of belonging to communities of practice and outside expectation and requirements. The unexpected emergence of 'good-enough' as being sufficient to meet obligations has potentially wider ramifications and might be regarded as a political 'hot cake'.

The research showed that the excellent teacher is able to satisfy both short-term and long-term views of the purpose of successful mathematics education. The short-term view is of the child as evidence of success, visible through meeting external policies and targets. This enhances the school's public profile and reputation, affecting parents' perceptions, so ensuring competitive continuance through attracting pupils. The long-term view is of building the child to become a contributing and satisfied adult with drive to pursue mathematics for its own sake. The respondents indicated that the child who is the product of excellent teaching will receive the teaching that is appropriate to their potential, acknowledging that this will not be the same for all. For some this may rest with the child possessing mathematical knowledge and skills for functional mathematics. For others, further to this, some children will develop and demonstrates understanding and control of mathematics. They will thereby become effective as well as efficient mathematicians enabled to appreciate the aesthetic attraction of the subject. For all children, they will be endowed with confidence and self-esteem that enables them to seek solutions to challenge.

The research indicated that lack of confidence in teachers of primary mathematics may arise from weak understanding of the subject, limiting the teacher's ability to extend and enhance the children's progress. The more lack of confidence limits and inhibits the teacher's thoughts, perceptions, and actions, the less freedom there is for pupils to develop understanding and independence, leading to reduced engagement. As a result, the child, instead of being pro-active in their learning, may become only reactive or even passive.

The biographies of the participants revealed that that mathematical confidence arises in different ways and at different times. There were various means by which it was acquired with conscious or unconscious dispositions framed by their past. In particular, it seems that it is possible to build on existing positive attitudes or to negate previous negative experiences though application of self-will and intent. Indeed, negative experiences, for the participants, were not a barrier but had the potential to create an evangelistic approach to mathematics teaching as they seized their personal agency with a determination that children should not have those experiences.

The research showed that each of the three identified knowledge elements requires more than meeting a check list of knowledge competencies; the three domains of knowledge are inextricably linked. What emerged was evidence of variations of understanding what was meant by subject knowledge, clouding distinctions between the respondents' views as it was not comparing like with like. This particular example of imprecision illustrates the potential for miscommunication that might occur at all levels when there are assumptions of common understanding. However, it emerged that for teaching, subject knowledge means knowledge and understanding of the interconnectedness of mathematics with an important role to inform pedagogy. Generic pedagogical principles are individualised to the subject through subject specific knowledge (pedagogical subject knowledge). This pedagogical knowledge the excellent teacher combines with knowledge of how children learn and of each individual child to achieve what they believe are outcomes of excellent teaching. Teaching strategies that require risk-taking and being creative act as barriers to less secure teachers, suggesting that it is unlikely for a teacher to be justifiably pedagogically confident in mathematics without good subject knowledge.

The teacher uses their knowledge to determine appropriate intervention and support, knowing that too little results in demotivation and lack of progress while too much inhibits development of independence and encourages passive pupils. Whilst it may not be possible to

make children learn, it is the teacher's role to lead, direct and teach, creating the best learning opportunities. The research showed that this occurs within an ethos of collegiate co-operation which encourages and expects teacher and pupils to take risks. This accommodates the important affective aspects of nurturing self-esteem and confidence. The teacher needs to act as a model, to enthuse, to have personality, character and passion. It is interesting that from Ofsted 2009 to 2014 the need to inspire and challenge was removed and the application of teacher subject knowledge to their teaching was changed to the delivery of knowledge to the pupil. Although both respondents' views and the literature dwelt more on knowledge than confidence and supererogation, it was evident in this research that all three themes are needed for excellence.

The role of managers is important as they need to have confidence and trust that the more open approach propounded as excellent will meet the necessary targets. Managers also need to commit to the staff development necessary to raise the level of mathematics teaching by all by creating the environment for greatest likelihood of success. The strategy of creating an appropriate setting therefore applies to both pupil and teacher learning. The research did not show agreement that all teachers could become excellent and identified three main reasons why this might not succeed: lack of capability; lack of desire or intent, or even recalcitrance; lack of confidence.

For all these, the teacher's individual professional identity is central. It may be that some teachers are not prepared, or able (through temporary or permanent circumstances) to reconcile possibly conflicting demands or to deploy pragmatic acknowledgement and acceptance of accountability and meeting two masters even if they sometime seem incompatible. As an addendum, the research showed that even the best teachers are unlikely to be able to sustain the highly demanding efforts required for excellent teaching all the time. This does not mean they are not excellent teachers, just that they may occasionally not teach an excellent lesson. Again, the pragmatism that pervaded the research is evident.

The research showed that excellence is an aspirational ideal. There was general agreement that there is a difference between good and excellent teaching with many examples of what is not excellent being cited. Two main outcomes emerged: that 'good-enough' is sufficient to meet the required external targets but that excellence would elevate the children's learning experience to that perceived to be the ideal outcome; that teachers possess 'guild knowledge' which acknowledges the intangibility of some aspects of excellence. Another consideration is that if supererogation was to become a requirement rather than morally desirable, this would then negate the principle of supererogation. If going above and beyond is a feature of excellence then excellence is also above and beyond and cannot be a requirement.

The respondents' diverse biographies will have influenced their perceptions of excellence. Contributing to a degree of commonality would have been the literature, their schooling and their HEI lecturers which would have retained a common core of curriculum and teaching. Nevertheless, the responses reflect individual, reflective, evidence-based beliefs of each individual respondent. It might be deduced that the participants subscribed to a predominantly social constructivist stance with learning co-constructed actively between teacher and pupil. The views expressed by the participants did not project the "'progressive' denigration of knowledge" (Gove, 2013:12) image of which teachers have been accused in which "teaching is marginalised" (*ibid*:11). Rather, they exhibited an acknowledgement that learning how to do mathematics involves routines and learning facts. This complements the application of what they know and can do to demonstrate understanding, combining procedural and cognitive learning. The respondents did not indicate that the excellent teachers need to subsume their beliefs, if these are not harmonious with the imposed requirements. Instead, part of their identity is to possess sufficient agency to know how to achieve what they believe in without compromise or disservice to the intrinsic benefit of the child and yet still meet the required, imposed targets.

The excellent mathematics teacher has a pragmatism that allows him to reconcile the need to meet the demands of two masters that are not necessarily compatible. This expediency is instrumental in enabling the teacher to know what the child needs to learn. By this means, the teacher embraces the intrinsic motivation of the child as a learner with his beliefs in the child to inform the intended outcomes. At the same time the teacher accommodates the extrinsic incentive of the child as the vehicle or instrument by which success is measured by meeting the requirements of externally imposed targets.

6.2 Potential contributions to theory, policy and practice

This research contributes to theory, policy and practice in several ways. First, it adds to knowledge, reasoning and theories of teaching of mathematics by identifying the multifarious nature of knowledge understood and possessed by the excellent teacher interlaced with confidence and supererogation. Teacher confidence is fundamental to supererogation although good will and moral intent also need to be present. If excellence was to be a requirement then so too would be each of the three themes (confidence, knowledge and supererogation). Second, it highlights the differences between teaching for short-term and long-term achievement and the potential contradictions teachers may meet. Third, the thought-provoking emergence of 'good-enough' gives rise to consideration of how policy expectations impact on teaching and invites discussion on implications for policy and practice. Fourth, while considering teachers as practitioners, the research locates them within communities of practice, developing awareness of the relationship between the concepts of context, individual professional identity, power and agency. It creates a perception of a shared reality of professionalism whilst allowing for individual differences to be considered in practice. It has the potential to move beyond the themes and dichotomies identified, using them not to confine but to begin reflection.

As a consequence, the intended audience of teachers, managers and policy makers can take from this research knowledge of what comprises excellent teaching in primary mathematics,

secure that the findings may be used to inform practice. This research will help teacher educators, advisors, inspectors, NGOs and in particular the policy makers to be more cognisant of teachers. The research has shown that teachers do not respond well to expectations that are too far outside their comfort zone or experience. From this questions arise about how excellence is to be achieved by those who are not prepared or able to 'go the extra mile'. The ways in which teachers talk about their practices are different from those expressed by policy makers and if not supported with this knowledge change is likely to meet with resistance through lack of ownership and agency. All teachers know they are players and that people hold different amounts of power within and outside communities of practice. The excellent teacher is proactive and uses her player status to ensure the requirements of the policy makers are met within what is best for the child.

6.3 Significance of the research

Significance may be considered in five ways. First the methodology sought to illuminate implicitly held philosophies and ideologies and how that translated to practice. This approach endeavoured to challenge assumptions of existing approaches to excellent teaching. Second the research used a process, accessed through the methodology, of bringing together the views of practitioners with literature and government policies and statements to give distinctive insights. The context of the study was unique in that it was embedded in a particular time in political debate and government change. It showed how this impacted on teachers, elucidating a strong sense of what is right within the deluge of directives for change. Third, the three themes offer a unique representation of the views and ideological stances of the respondents, enabling articulation of the sometimes seeming elusive unquantifiability of excellence. Fourth, the dichotomies insightfully revealed depths of the complexities of teaching. Fifth, the metaphor of Meccano® illustrates those principles which effectively sums up the beliefs of the research participants. This metaphor has great potential for development

as a vehicle for clarity of purpose for teacher education and training, for practitioners and policy makers, providing an accessible and pertinent context.

6.4 Critique of methodology and methods

The research paradigm, approach and method and the theoretical framework for interpretation in this research are mutually enhancing. The preceding discussion has illustrated the close match between acknowledgement of subjectivity in a qualitative, interpretative approach and the theoretical stances of socioculturalism and social constructivism (as explored by Ernest, 1998 and Wenger, 1998, 2010). This relationship sits also between the analysis of interview data and recognition of the communities of practice in the dialogue between teachers and teacher researchers. Interpretativist knowledge perhaps inevitably reflects the values of the enquirer, even as it seeks to reconstruct others' sense of meaning and supporting beliefs. The interpretative framework exemplified within communities of practice is complemented by the use of social constructivist theory in developing an honest and open analysis of data in ways that are respectful of the rights of interviewees. It might have been useful to draw on more than one theoretical framework although this may have further confused interpretation. The choice of communities of practice was used deliberately in order that there was the potential for seeing the extent and the ways in which teachers' beliefs are influenced by internal and external factors, conscious and unconscious dispositions, as drawn out by Wenger (1998, 2010). It might have been interesting to consider one of the other of the seven theorists.

It is important to recognise that the interpretation blends my own and the teachers' histories in ways that are not always clearly divisible. Furthermore, it was undoubtedly the case that I came to the research with my particular view of the nature of excellence in primary mathematics teaching but emerged from it with a far more nuanced interpretation of what that might be. Researchers must give particular consideration to their position in relation to their enquiry as whatever the situation, their role, identity and relation to it will be of

profound importance to the way they conduct their enquiry and its results. I was investigating a field within which I have worked for well over a decade. As Ely (1991) reflected, researching the familiar may seem advantageous but it may also mean that I may have overlooked important aspects of the situation, and so needed to ensure I maintained my critical gaze. It is important to acknowledge my pre-existing beliefs about the field of excellence in mathematics teaching and that these will have been brought to bear in what was perceived in the data and in defining what was important in reporting the data. Thus the conclusions rest on the researcher's interpretation of the experiences, attitudes and beliefs of the teachers who were the respondents at the time and place during which the research took place.

In interpreting the views of individuals, it is incumbent on the researcher to represent those individuals as truthfully and honestly as possible (Kvale & Brinkmann, 2009). The threat to that came in the form of attempts at generalisation across the group. I may well have unconsciously looked for commonalities and perhaps assumed group agreement, when the teachers were very much individuals. Their individuality was rooted in their past histories and their present teaching context and this was different for each one. Throughout the analysis there was movement from the individual to the group and back to the individual and this is illustrative of the difficulties involved in attempting to deconstruct practice as something logical (Grenfell & James, 1998). Therefore the search for commonality was perhaps more a shortcoming in interpretation and my use of the method, than a failing attributable to the method. That said, there was evidence of some patterns in the teachers' responses despite their widely differing modes of expression.

The untying of the complexities of teachers' understanding of their practice was a very important outcome of the research to address the research question with depth and breadth. The data were interviews in which teachers described their beliefs and practice, rather than observation of actual practice and as such there was no data against which actual practice could be tested against the intents and aspirations expressed. Additionally, this research has

focussed on teachers rather than children (or parents, governors or policy makers). It was clear that there were some findings specific to the children the teachers had encountered and hence it cannot be assumed to be true for other situations and could not be tested against the views of the children.

Nevertheless, potential breadth in analysis was considerable, made clear by the identification of themes and dichotomies each of which is possibly wide-ranging and each of which could have made a single research focus. However, it is perhaps the nature of interpretative enquiry that attempts to define the research field might end in findings that cover more ground than was originally intended; the researcher cannot know either what the data analysis might generate or the ways in which the views and beliefs of the participants might be manifest (Greene, 2010). Social and educational interactions can only be understood within their context (Denzin & Lincoln, 2013b) and choices were made about the foci for analysis. These were governed principally and appropriately by the frame of communities of practice and situated cognition, which of itself is a broad construct open to many different definitions and interpretations by researchers.

It could have been useful to consider one particular view of excellence and use this as the point of reference in analysis of practice. For example, it might have made sense to draw solely on the theme of knowledge in interpreting teacher's practice because this aspect arises a great deal in the literature. Within this, for example, there might have been room for greater attention to and analysis of subject knowledge against the full range of ways in which this portrayed itself during the interviews. Another possibility might have been to focus on the extent to which teachers are affected by years of curriculum control (noted by Moore *et al*, 2002), relating to the interplay of successive changes in policy with teacher identity and the subsequent impact on their sense of agency to affect change. Alternatively, in conceptualising the challenges for teachers in achieving excellence in mathematics teaching, this research went some way to joining differing views from government policies and research about how

children learn mathematics and what is a desirable outcome of teaching. Analysis of this particular focus could have further explored possible links.

6.5 Reflections and limitations

The research approach made it possible to unearth assumptions underlying practice. It provided bridges across the arbitrary divide of the objective professionalism in response to policies and directives, and the social constructivism of the practitioners. As argued, the resultant outcomes can be deemed credible, confirmable, dependable and transferable.

On a personal level, this research has challenged my certainties and pre-conceived notions, although my personal perspective was not explored. Professionally, for me, five reflective points arose, highlighting the individual nature of teachers and their professional identities. The first was discovering differences in teacher motivation with respect to changing practice and hence second, the degree of separation between central policy makers and teachers as enactors. Third was the extent to which teachers do or do not engage with theorising on the practice of teaching and fourth, teachers cannot easily be categorised or pigeon-holed. Finally, the research put a human face to the teacher story and showed that continuity and belief is more powerful than structural changes.

It may be considered that there are two further limitations in the research as undertaken but I will argue they are strengths. The first is that the sample of participants may be considered to be narrow and hence a shortcoming, creating a possible circular debate. However, the relative homogeneity of the type of participants, bound by cultural and educational commonalities within the world of mathematics education, possesses diversity amongst the individuals. The second is that only one method of data collection was deployed albeit with two outcomes. It might be reasoned that more direction to the interviews or additional data collection methods would have help avoid any gaps that may have later emerged during analysis of the findings. However, the nature of the interviews offered freedom to the respondents to provide their

own insights whilst permitting me as the researcher to pick up and pursue points that arose. The resultant richness of data would have been lost with more directed data collection.

6.6 Implications and recommendations for further research

This research achieved a range of answers from the particular population that formed the sample to the research question which asked, 'How is excellence in primary mathematics teaching perceived by primary teachers and mathematics teacher educators in England?'. At all stages, tantalising possible divergent threads surfaced and it became evident that discipline was needed to focus sufficient to gain depth rather than breadth. Further research may continue to explore definition of terms from other relevant groups of respondents. However, it could move on to determine how excellence is to be achieved through the three themes. This could include further exploration about how confidence is established, maintained and enhanced, or how to apply knowledge once acquired. These create identity and agency leading to supererogation. This could be through:

- Longitudinal studies
 - Long-term impetus and impact of MaST initiative
 - Teaching strategies
 - CPD
 - Longer term effects and impact on further education, career choice and progress, views of mathematics.
- Broader
 - sample to include non-mathematics specialist teachers, recipients of teaching (current, secondary pupils and young adults), parents, governors, LA, education ministers
 - methods – observations, document review
 - SEN
 - Other stages of education

- International perspectives

6.7 Conclusion

This research makes a distinct contribution to the body of knowledge by creation and synthesis of theory and empirical data creating new insights and interpretation thereby offering ways forward to educators and policy makers. A teacher with confidence and knowledge may achieve teaching that is good enough to meet required targets but improvement to excellent may be hindered by the teacher being wedded to habitual practice and certain ways of thinking which inhibits potential for change. Also, teachers with limited understanding of mathematics might lack confidence, not know what they do not see, may make assumptions about children's understanding and take a safe approach to their expectations of their pupils. Teachers are supported by their membership of each school's community of practice, which provide a structure for professional development. The Meccano® metaphor provides a tangible, relatable vehicle available to managers to upgrade the quality of teaching mathematics. Good enough teaching may be sufficient to meet required targets but nurturing excellent teaching through the triple development of confidence, knowledge and supererogation in the teacher will result in the same excellent outcomes embodied in the child.

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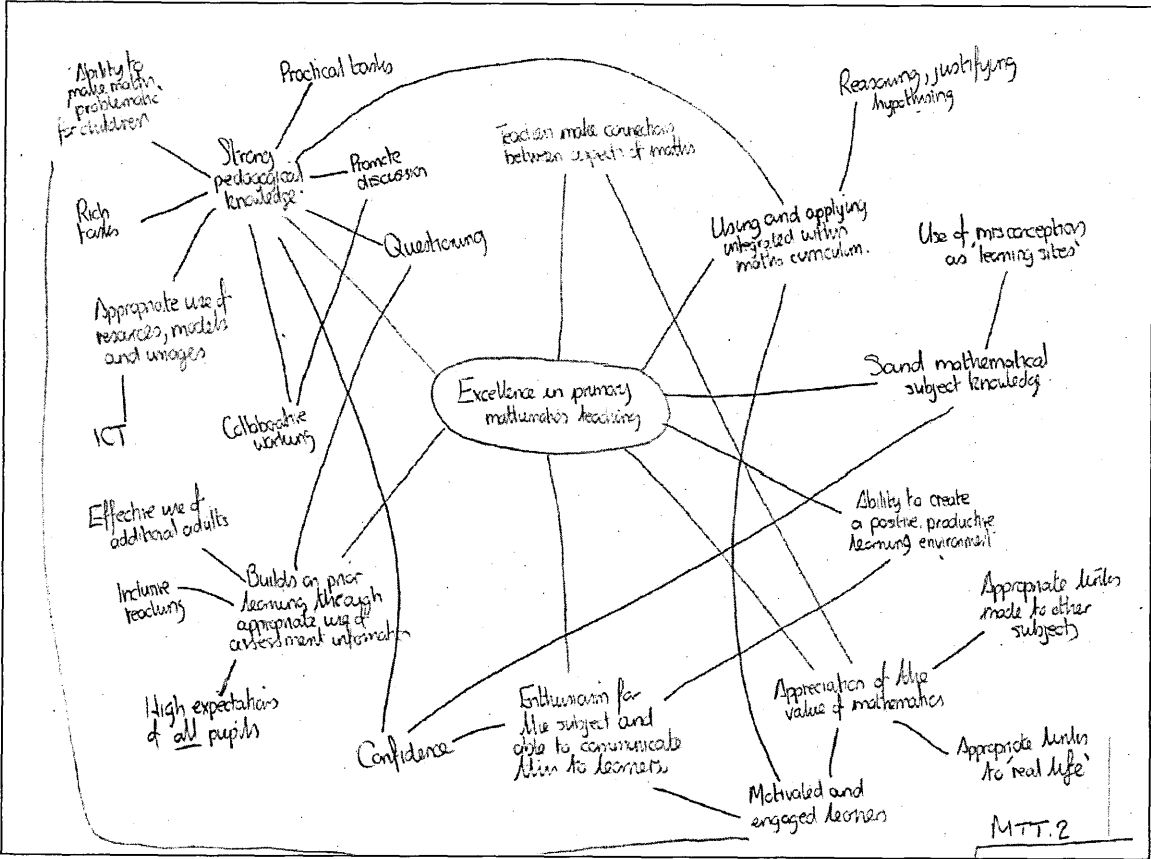
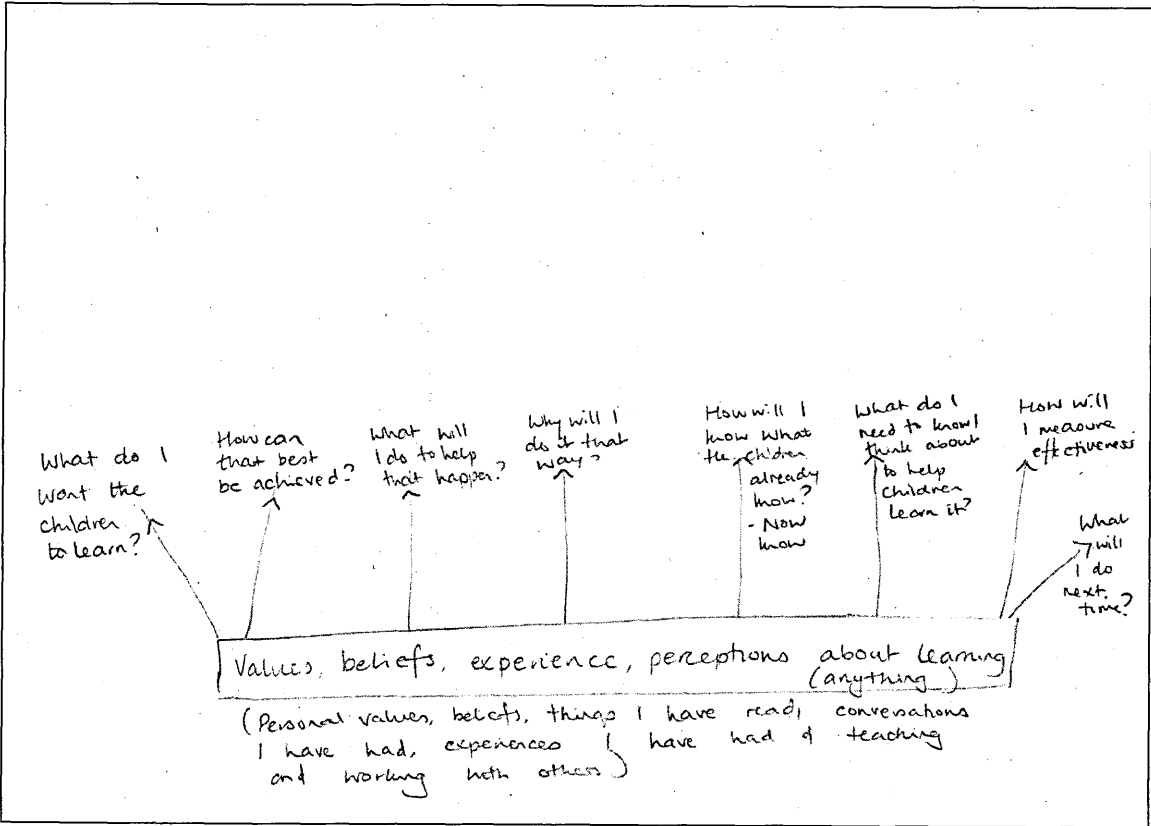
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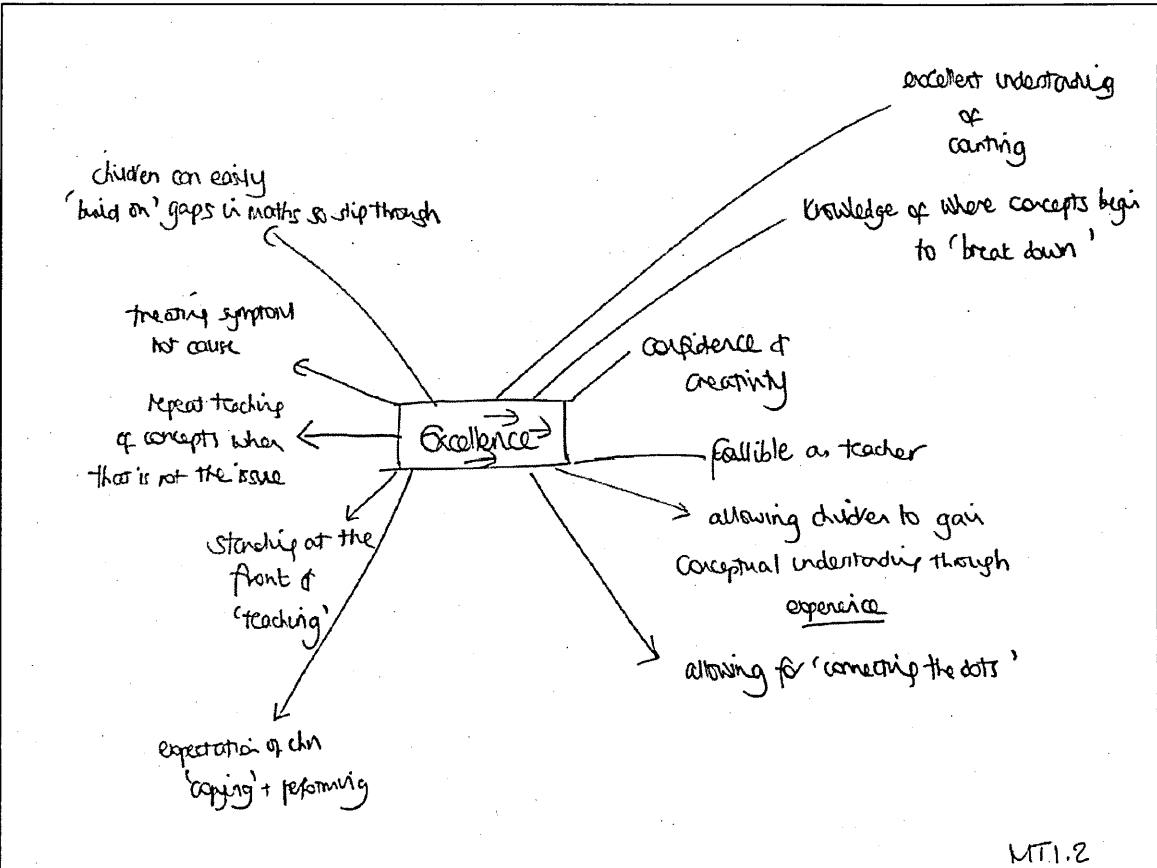
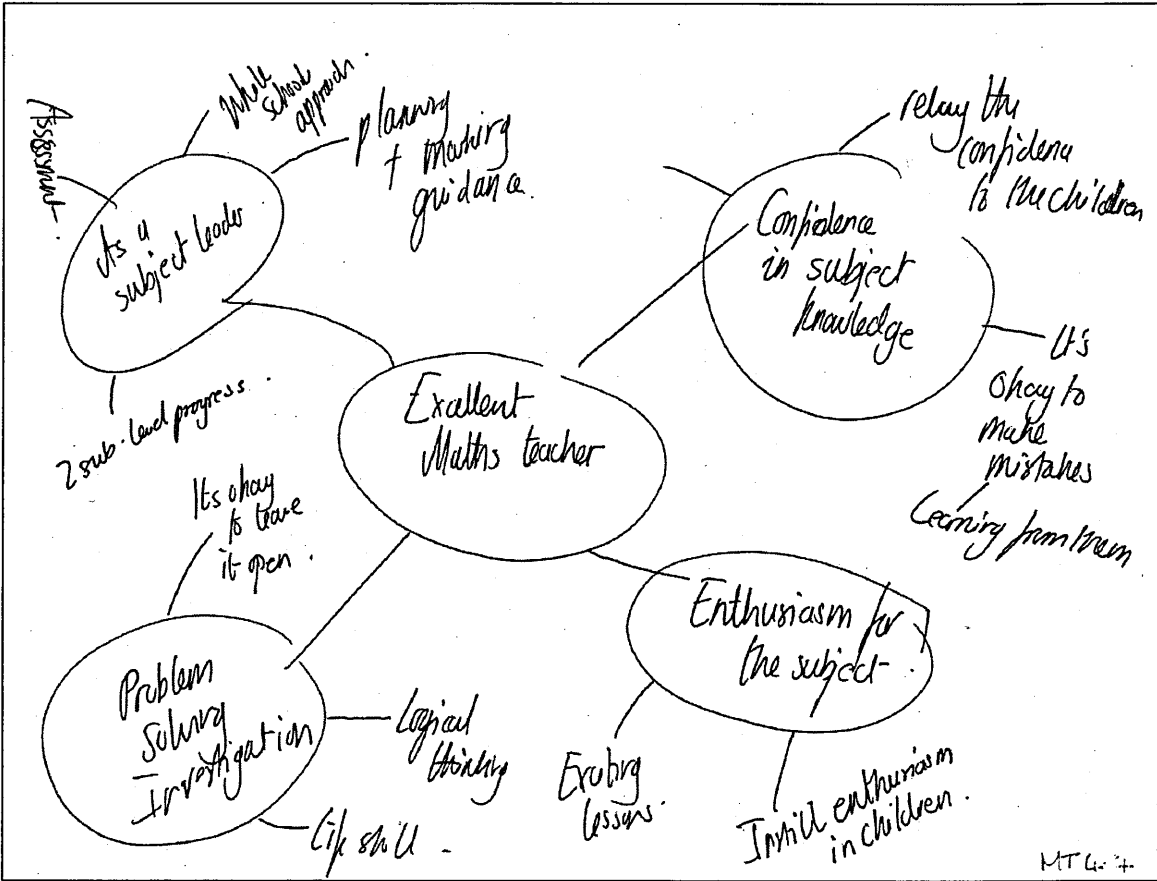
Appendix 1: Overview and cross-reference of seven theorists with emergent themes highlighted

Identity/ narrative /culture (Bruner 1990-97)	Figured/ worlds (Holland et al 1998)	Communities of practice (Wenger 1998)	Discourse; power/knowledge (Foucault 1972-84)	Social cognition; Self-efficacy; Human agency (Bandura 1977-97)	Capitals; Habitus; Field (Bourdieu 1986)	Ecological system theory (Bronfenbrenner 2004)
By telling our stories we create our identities, learn about self. Agency presupposes choice. Self as a construction from culture to mind and mind to culture. Human reflexivity – consider the past and alter the present or vice versa. Education exists in a culture to find an identity in that culture. Those in power in early life create child's identity (child cannot know anything but what is communicated). Those in control (experts & their knowledge)	Identities lived in & through activity. Human agency limited when little power. Self – socially constructed. When we speak we state our position. Sociocentric/ interdependent v egocentric/ independent. Human agency – capacity of people to act upon their world. FW- provide context of meaning & action in which social position & relationships exist - take shape & give shape by & to participants. Identity & agency formed dialectically & dialogically. Self-development in and through activities. Newcomers inducted. Parallels Bourdieu's 'field' – positionality. Paradox – how can members of world be free of entrapments that they create in that world? Relational & positional identities. (Martin) Members of CW seesaw	Learning, meaning, identity for individuals, communities, organisations. 4 premises: <ul style="list-style-type: none">We are social beingsKnowledge as competenceKnowing as anticipating active engagementMeaning produced by learning. Learning inherent to human nature. Learning as the vehicle for evolution of practices and inclusion of newcomers. Learning as participation. Learning develops and transforms identity. Learning as social energy and power. Social practice as the productive and reproductive specific ways of engaging. Social system of shared resources. Identity as social formation of person, cultural interpretation &	Discourse – creates truth, morality, meaning - created & perpetuated by those with power & mean of communication. Those in power in early life create child's identity (child cannot know anything but what is communicated). Those in control (experts & their knowledge) decide how we should act & who we are by deciding what we discuss. Power strategies produce knowledge. Central, validated knowledge and local knowledge with no common meaning. Power only exists in action – a relation of force. Power constitutes the individual who in turn is its vehicle.	Human behaviour as continuous, reciprocal interaction between cognitive, behavioural & environmental interlocking determinants of each other. People live in sociocultural settings that differ in shared values, social practices – commonality of efficacy does not mean all agree which serves useful purpose. People not simply reactors – they select, organise, transform stimuli that impinge. Individuals serve as principal (not sole) agents of own change. Beliefs in personal efficacy – key factor of human agency. Misjudgement of personal efficacy can produce adverse consequences. SCT rejects duality of self as agent and self as object. Rejects behaviour regulated solely by external. Agents transaction people both producers & products of social patterns. Personal, political efficacy	Constructivist analysis of relations. Human capital created by changes in persons using skills and capabilities. Social capital created through changes in relations between persons. Human & social capital in family contribute to potential – high social can offset low human. Balance between capitals within education creates opportunities. Human actions result from interrelationships between thoughts & actions of individuals &	Four nested systems <ul style="list-style-type: none">Micros (family, classroom)Meso (two micro interacting)Exo (external, indirectly influence eg parent workplace)Macro (larger socio-cultural context) + Chrono (evolution of other 4 over time) Individual's contribution to development made by synthesis & integration between active person and active context – constitute driving force of human development. Social development lit on effects of peer groups, power stability influence. Human capacity to

<p>decide who we are by deciding what we discuss. Identities lived in & through activity. Relational & positional identities. Identity & agency formed dialectically & dialogically. Learning, meaning, identity for individuals, communities organisations. Identity as social formation of person, culture interpretation & markers of membership. Learning develops and transforms identity. Beliefs in personal efficacy – key factor of human agency.</p>	<p>between credulity & disillusionment. 3 perspectives (Clammer et al) How one figures one's own world determines responses to others. Where does knowledge come from? FW reconciles ism & constructionism. FW – discourses built up by relational logic. Practice as doing in historical & social context to give structure and meaning. Includes the said, unsaid and implied. Agency transaction people both producers & products of social patterns. Agency presupposes choice. Education exists in a culture to find an identity in that culture. Human actions result from interrelationships between thoughts & actions of individuals & world in which they operate. Social agents develop strategies adapted to social world. Person's ability to shape own development.</p>	<p>markers of membership. Practice as doing in historical & social context to give structure and meaning. Includes the said, unsaid and implied. Human actions result from interrelationships between thoughts & actions of individuals & world in which they operate. Social agents develop strategies adapted to social world. Education exists in a culture to find an identity in that culture. Collective efficacy relating factional interests to shared purpose. Human behaviour as continuous, reciprocal interaction between cognitive, behavioural & environmental interlocking determinants of each other.</p>	<p>Knowledge produced in agents/experts relationships. Neoliberalism – proformativity - experience is nothing, productivity everything Cultural resources as public forms & social tools – originate outside & are imposed recurrently to be self-used. Knowledge a necessary condition to being (Descartes cogito ergo sum) Where does knowledge come from? FW – discourses built up by relational logic. Learning as social energy and power Constructivist analysis of relations. Social development lit on effects of peer groups, power stability influence. Education exists in a culture to find an identity in that culture.</p>	<p>measured by impediments to change people belief they can surmount. Collective efficacy relating factional interests to shared purpose. Human agency limited when little power. Human agency – capacity of people to act upon their world. Identity & agency formed dialectically & dialogically. Paradox – how can members of world be free of entrapments that they create in that world? How one figures one's own world determines responses to others. Individual's contribution to development made by synthesis & integration between active person and active context – constitute driving force of human development. Human capacity to grow & adapt. Person's ability to shape own development. Agency makes humans active producers of own development. Agency presupposes choice. Social agents develop strategies adapted to social world.</p>	<p>world in which they operate. Social agents operating with habitus (series of dispositions, subjective) for field (structured social world with own rules etc – objective). Social agents develop strategies adapted to social world. Habitus & field reciprocal, can only exist in relation to each other. Parallels Bourdieu's 'field' – positionality. Relational & positional identities. Exo (external, indirectly influence eg parent workplace)</p>	<p>grow & adapt. Person's ability to shape own development. Human beings create environments that shape course of human development. Agency makes humans active producers of own development. Objective and subjective elements influencing – emotionally & motivationally loaded. Identity as social formation of person, cultural interpretation & markers of membership. Human behaviour as continuous, reciprocal interaction between cognitive, behavioural & environmental interlocking determinants of each other.</p>
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Appendix 2 – Mind-maps examples





Appendix 3 - Example of processing data for emerging themes

The presentation of data below contains quotations mainly from the interviews with MTs 11, 12 and 13 with any quotations drawn from the mind-maps shown in red. Emergent themes are highlighted in yellow as a prelude to analysis.

What do you believe is excellent primary mathematics teaching?

MT11 notes the need for the children to be 'at the focus of it' and one extension of this she proposes is that the excellent teacher would have the flexibility to 'move with the children (forwards, backwards and sideways)' and not to 'stick with [...] one idea'. She mentions this in the context of class changes so the teacher is to be able to teach in 'a different way [...] being able to adapt' so the children adjust but mostly she talks of flexibility within each lesson. In this, the need for flexibility might be when it becomes evident that it is 'going downhill' or even 'knowing when to stop if [...] not going to plan' which is 'quite hard to do' or to allow the lesson to 'go off at a tangent' but know that you can 'bring it back'. By allowing this to happen, in the short term (a day or two), it 'probably doesn't affect' the outcome intended as the excellent teacher knows 'the overall aim [...] and direction work is taking', although a limitation of adopting this approach is that 'it may take twice as long'. She goes on to say that the excellent teacher will achieve what was intended 'but maybe not by the pathway that [they] thought [it] would'. The intent behind a flexible approach is to provide opportunities to get 'children thinking for themselves' and 'find out things for themselves' so they gain understanding because 'they want to know'. However, this calls for confidence. For example, the teacher needs to be able to listen to the children and know if what they are saying is valid or not 'including mistakes which we can all learn from'. Even more it means that if the teacher does not understand it they have the confidence to work with the children to clarify and then 'help them and move them on'. Coupled with confidence enabling the teacher to be excellent is the possession of knowledge, both of mathematics and of pedagogy. To take a flexible approach to meet the needs of the children means that the teacher needs to know when and

how to 'take the children on or move them back' even when there are 'six different things needing to go on'. However the excellent teacher does more than manage. Through their confidence and knowledge, they use teaching strategies that ask children to 'push [...] or challenge themselves' within an 'environment where it's ok to admit you don't understand'. As a result the children get 'much better at thinking', 'enjoying being able to be like that' and finding challenge to be motivating. The excellent teacher makes 'children feel proud of their achievements' by 'creating that atmosphere where everything's valued'.

As her first point, MT12 has 'every child's needs' and 'facilitating their progress'. To do this the excellent teacher has a 'very in-depth awareness' of 'exactly what their issues are and exactly what it is they can't do. She notes that this starts from knowledge that enables the excellent teacher to avoid 'keep repeating and building on things that aren't there' and means they can 'work out that crucial bit where it starts to go wrong', rather than 'treating symptoms not cause'. She has a particular idea that it is 'easier for children to get by in maths' with lack of understanding being 'masked quite well' and they 'can easily build on gaps in maths so slip through'. It takes an excellent teacher to 'know where the problem is' and avoid 'repeat teaching [...] when that is not the issue'. So knowledge is central as 'you have to know what you are doing and why you're doing it'. This again requires knowledge of mathematics as well as of pedagogy so that the teacher can 'go through every step ... why this works' or why if put differently 'it doesn't work'.

She believes that 'you can't make someone understand maths' and so the excellent teacher needs to be 'totally confident', arising from knowledge, to use teaching strategies that provide opportunities for 'children to gain conceptual understanding through experience' 'to pick up concepts'. An important part of this is listening to the child, especially if the child is 'mentally quicker' than the teacher and 'having the confidence to think ... ok that's fine'. An excellent teacher is 'fallible' and children benefit from knowing this as this creates mutual respect.

'There is no benefit of children thinking we're perfect, it's just not how life is'. In keeping with

this idea, the excellent teacher also has to be **pragmatic**, reconciling idealism and demands of accountability. To someone looking in from outside, excellent teaching is **not necessarily 'an obvious thing'** but perhaps 'an awareness a teacher has in the classroom'.

MT12 maintains that teachers 'can't make it go in, [...] can't make them understand concepts and 'making children learn it' does not mean they understand it, even though they can 'churn it out when it's required'. The excellent teacher 'obviously play[s] a massive part in children gaining a 'really **true maths understanding**' rather than '**an expectation of [...] copying and performing**'. The children need to be able to 'figure it out for themselves' and the excellent teacher needs 'to allow that to happen' which requires '**confidence and creativity**'. As she says, 'it's connections isn't it, maths' and so 'excellent teaching is being a little more creative about how you **allow the children to join the dots themselves**'. When planning, the excellent teacher thinks about 'the way that you inspire the children to learn' and confidence that arises from strong subject knowledge provides the excellent teacher with '**flexibility** in the way they teach in their classroom'.

MT13 gives less definite distinction between an excellent mathematics teacher and a good one. He notes that the mathematics is to do with 'interconnectivity' and excellent teachers '**understand** how the different parts of maths stick together' and he suggests that excellent teachers are then able to '**get the children to start finding** those links as well'. Children need to ask questions such as '**where am I going next?**', '**how do I know?**' and '**what do I already know that is going to help me?**'. This is achieved through a **creative** approach that draws on 'children's life experiences' where the teachers '**open out maths** as something beyond learning a few fractions and a few procedures'. Four times he notes the need for teachers and pupils to '**take a learning risk**'. Underpinning this approach is the excellent teacher knowing when the children are 'missing important pieces of knowledge' and so being able to 'to go back' to the basic concept, such as counting. Another indication of an excellent lesson is one in which a teacher has 'an area of strength' with a 'better **pedagogical understanding**' so they will 'have a

more open lesson' in which the route to learning might be 'really circuitous'. However, if the teacher is less strong 'they will go back to a more structured lesson', which may be inferred as not excellent.

In addition to pedagogical knowledge, the excellent teacher has knowledge of the subject that provides 'confidence in teaching and learning' to make 'critical decisions about what you need to teach, [what is] relevant here'. Part of this is the quality of planning but this is 'not formulaic'. The excellent teacher will interpret planning documents, 'rewriting them for themselves' so that they are 'making those links and creating activities [...] which are rich and have meaning beyond learning your number bonds'. These teachers also 'scribble on meaningful notes' showing how they have interpreted the needs of the children during the lesson and in preparation for the next. He acknowledges that the strategies adopted by the excellent teacher need to be tempered as 'part of the deal is that you need good statistics at the end of the year' as it is 'the thing we are most strongly judged on'. He does also say that although this is 'not the be all and end all' his results have improved through some adoption of the excellent strategies.

The least articulate and fluent part of the interview is when he tries to define an excellent lesson. He says 'quality of questioning', 'pushing children's learning on' and restates 'pedagogical understanding'. He also uses phrases such as 'it's that whole bit about you feel something', 'you know it's excellent', 'sometimes that quite hard to unpick', you get a feeling' and 'if you are going to be excellent you have to have that extra bit'.

Appendix 4 - Study information sheet and agreement form

Project information sheet

Study title: An examination of conceptions of excellence in primary mathematics teaching.

Invitation paragraph: I am a senior lecturer in the Faculty of Education, Health and Social Care at the University of Winchester and a Doctoral student at the Open University. For my doctoral studies I am examining the concept of excellence in teaching primary mathematics. The study will consider the views of the literature, including government documents to provide background, indicative definitions and the general rhetoric surrounding the issue. The data collection will take a case study approach examining the views, beliefs, conceptions and practices of HEI teacher educators, starter trainee teachers and experienced teachers. In asking you to participate, I need to ensure that you understand what the project involves and what you will have to do so please take time to read the following information and feel free to ask if anything is unclear.

Participation: Taking part in this study is entirely voluntary and you are free to withdraw at any time without giving reason and without penalty and any existing data disposed of according to your wishes.

Procedure: The methods for data collection will involve interviews, using audio recording. Interview transcriptions will be made available for agreement.

Confidentiality: Any information gathered during this study will be made confidential such that nobody may be identified. In accordance with the Data Protection Act (1998), it will be stored in a secure place and disposed of appropriately once no longer needed or earlier, if indicated.

Contact for further information: If you have any questions about the study, please contact me in the first instance, on judith.mccullouch@winchester.ac.uk . Alternatively you may contact the Faculty Director of Research, stephanie.spencer@winchester.ac.uk or my doctoral supervisor j.lathlean@soton.ac.uk .

Approval: The study has been approved by both the Faculty Ethics Sub-Committee at the University of Winchester and the Human Research Ethics Committee at the Open University.

Informed consent: By signing the form below you agree to take part in the study and for the data gathered to be used for reporting on the project.

I agree to take part in Judith McCullouch's doctoral research project. I have had the opportunity to talk with her to gain understanding and understand the nature of this consent, as described above.

Name:

Signature:

Date:

Copy to participant and JMcC